Renewable electricity in 5GDHC

DECARBONISING EUROPEAN CITIES

Interreg North-West Europe D2Grids

celsius

Mathilde Henry

Consulting Project Manager in energy transition

GreenFlex

Emilia Pisani

Communications Officer Moderator

celsius

Interreg North-West Europe D2Grids

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The Celsius Initiative

- a demand driven collaboration hub -

Interreg North-West Europe D2Grids

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Accelerate the **energy transition** through the deployment of **smart and sustainable thermal solutions** in **cities.**

Don’t re-invent the wheel!

- ✓ Continuous **knowledge sharing** through the newsletter, webinars, workshops and the Celsius Toolbox.
- ✓ **Hands-on support for cities** through tailormade discussion groups.
- ✓ Understanding and influencing **European policy**.
- ✓ Support **innovation, replication and scaling** of pilots and demonstrators.

A sounding board for local actors

- ✓ Built on a **co-creation process** for **peer to peer** knowledge exchange and inspiration.
- ✓ Including a **systemic approach** to address key challenges through exchanges **with experts from across Europe**.
- ✓ Promoting **proper planification** for **successful implementation** of sustainable thermal energy networks.

Interreg North-West Europe D2Grids

Join us!

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eurac research

RISE Research Institutes of Sweden

celsius

City of Cologne

Gemeente Rotterdam

DG ENER

CONSTRUCTION21 IMPULSER LA VILLE DE DEMAIN

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Climate-KIC is supported by the EIT, a body of the European Union

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ENERGYCITIES

IMCG

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City of Gothenburg

FEDARENE

Covenant of Mayors for Climate & Energy EUROPE

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nfv Norsk Fjernvarme

Comhairle Cathrach Bhaile Átha Cliath Dublin City Council

LUNDS KOMMUN

REGEA North West Croatian Energy Agency, Croatia

EURO CITIES

UMEÅ ENERGI

AKCIJU SABIEDRĪBA RĪGAS SILTUMS

HOFOR

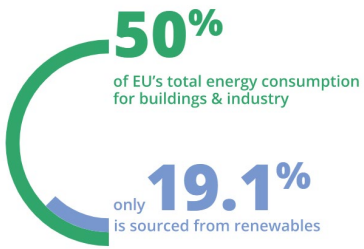
energo Utility of Rijeka, Croatia

D2Grids, a European Consortium to develop 5th generation of district heating and cooling

About D2Grids project

Objective:

Increasing the share of renewable energy in North-West Europe's heating and cooling sector by accelerating the roll out of 5th generation district heating and cooling



HOW?

Industrialisation:
Producing a standardised technological model, increasing the adaptabilty and replication of 5GDHC systems.

Commercialisation:
Clarifying the business model of 5GDHC andpromoting 5GDHC towards the industry.

Education:
Developing training modules and courses to develop a skilled workforce for building and maintaining 5GDHC technologies.

Pilot sites:
Demonstrating and testing 5GDHC

Project duration: **2018-2023**

D2Grids partners and locations

Lead partner

MINE WATER, A BASIS FOR SUSTAINABLE ENERGY
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Project partners

Asper, Open Universiteit, Paris-Saclay, Clyde Gateway, Nottingham City Council, VITO Energy Ville, FUW Stadtwerke Bochum, brgm, GreenFlex, Construction21, EcoTransFaire, Plymouth City Council, Seqens Groupe ActionLogement, Scottish Water, LLC & Associés Avocats

Subpartners

Energiepark, Stadtwerke Bochum, stroom versnelling, Fraunhofer IEG, Nordic Energy

Agenda

What is 5th generation of district heating and cooling?

How can solar, and in particular PV be used in these grids?

Round table of the pilot sites of D2Grids

Case-study: DHC grid & solar in Sweden

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Herman Eijdems

Director of Innovation

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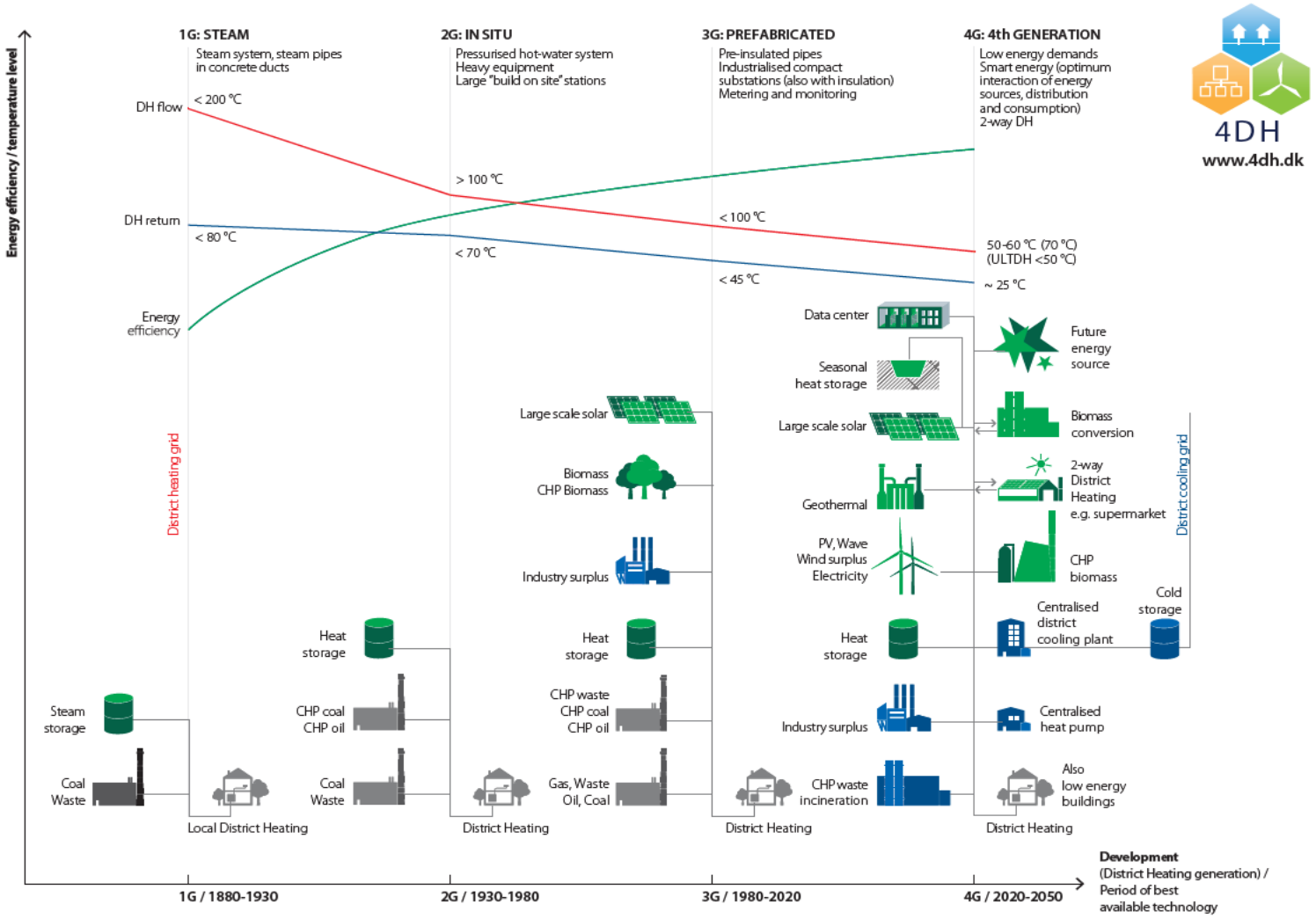
Development of DH grids

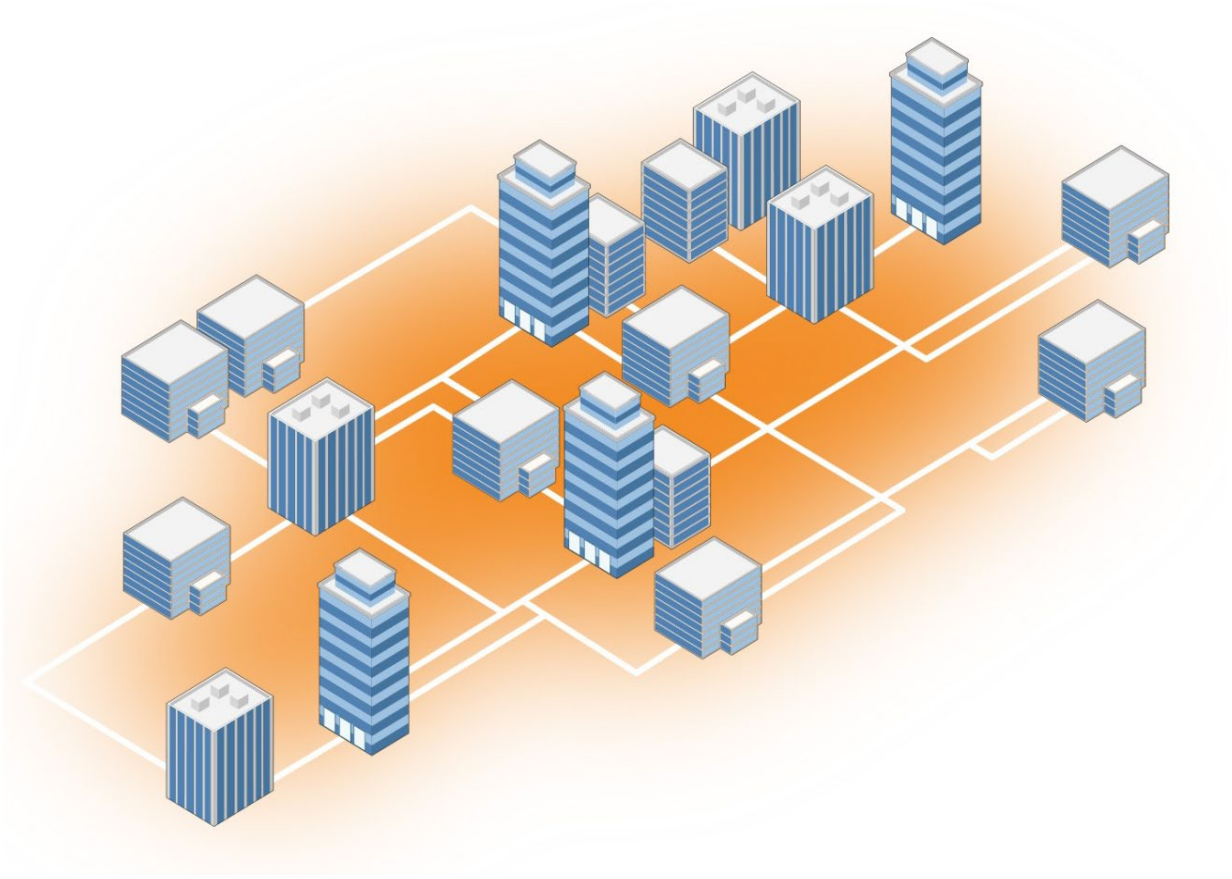


We see in the development of grids a huge focus on central plants and generating energy in a greener way

which means:

- Dependant on weakest point in the grid
- Not flexible to enduser modifications
- 24/7 need for delivering heat 'at the front door' with large efficiency losses
- No cooling supply integrated

5GDHC: from central plants to decentral



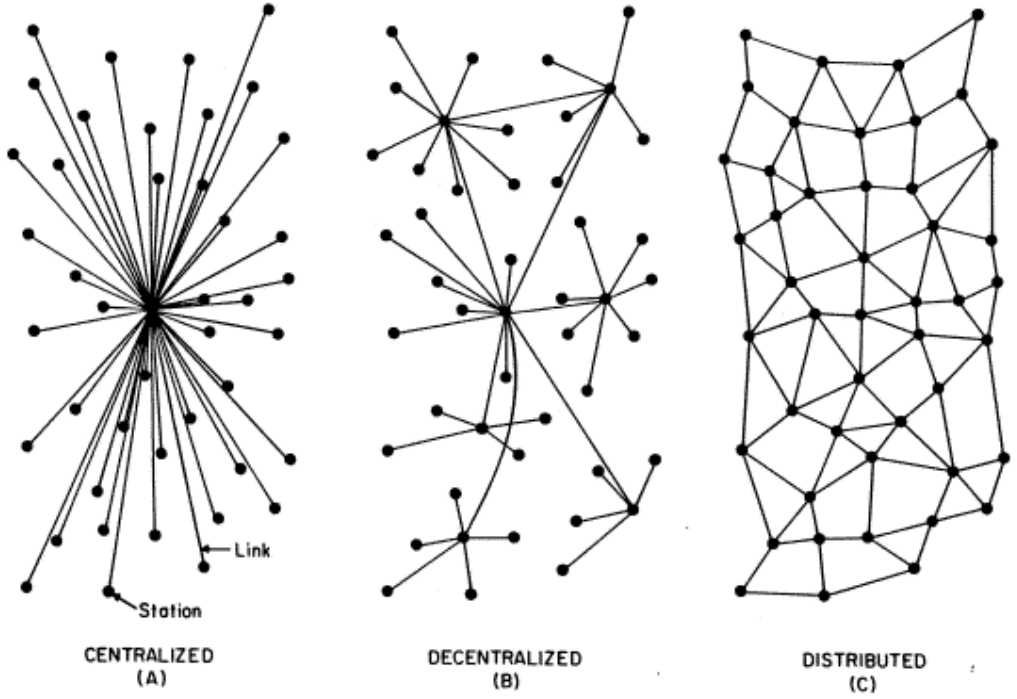
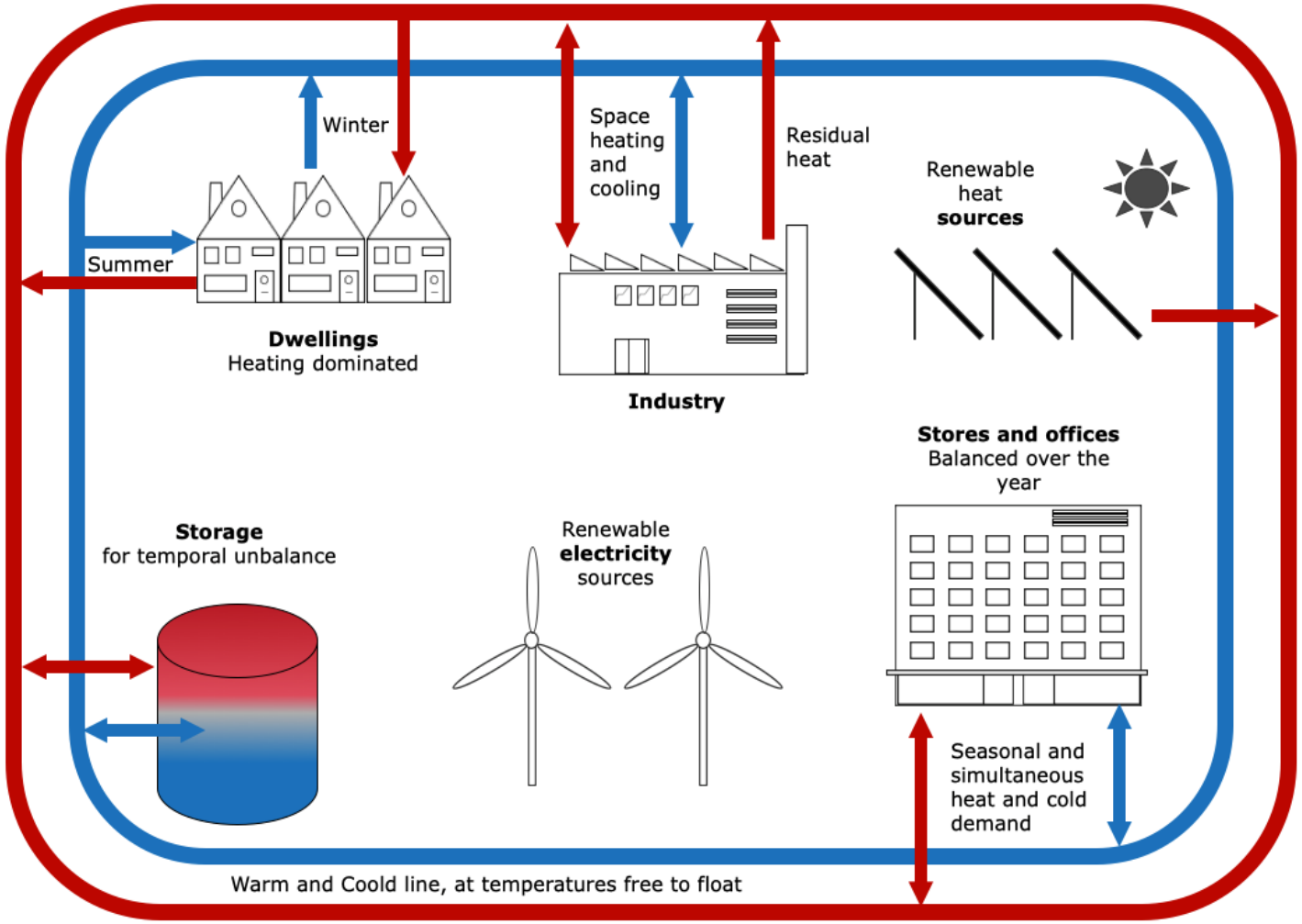


FIG. I — Centralized, Decentralized and Distributed Networks

5GDHC: a thermal twin pipe system

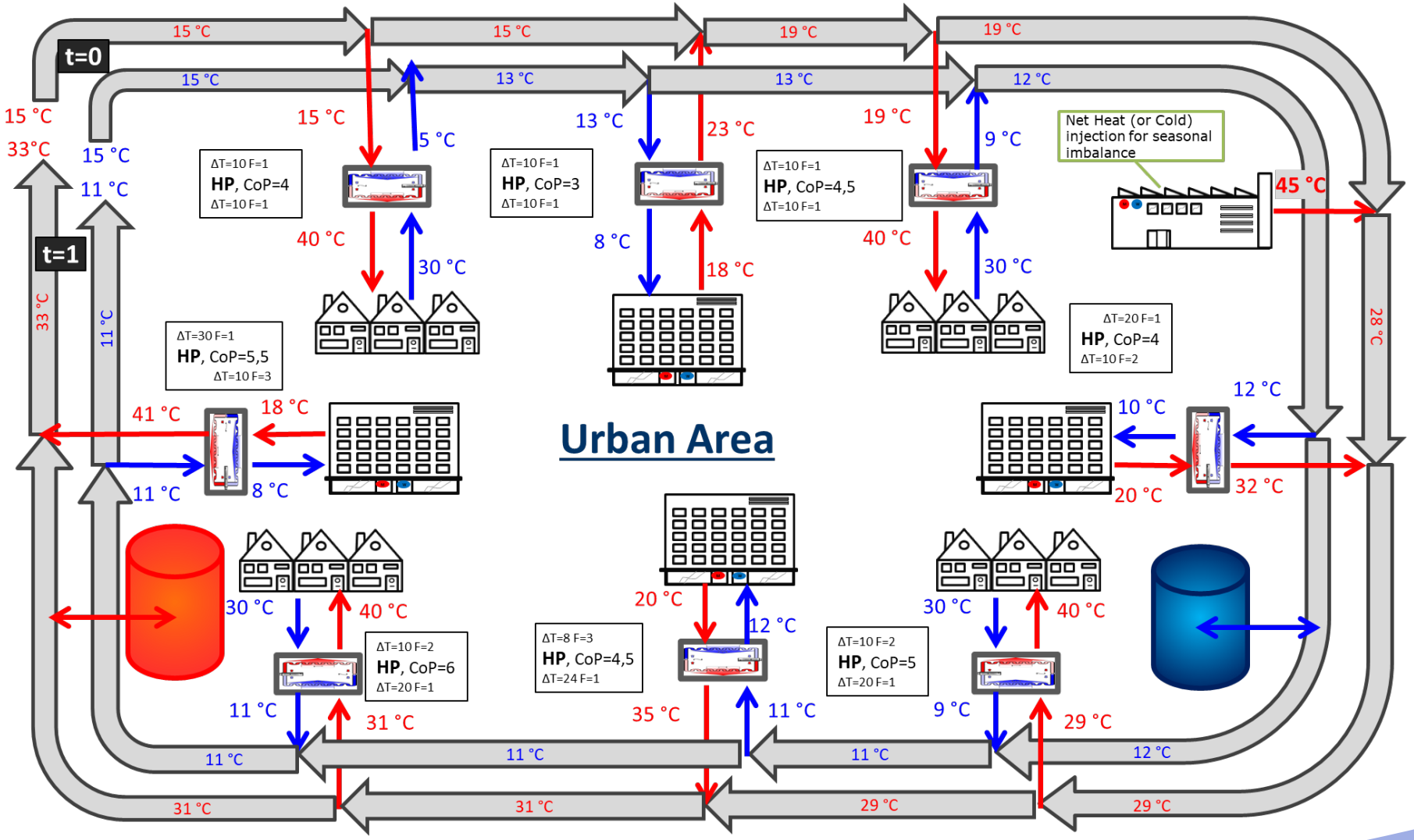


A grid that provides:

- Cooling and Heating
- Is demand driven
- Consumers are prosumers
- Local sources and storage
- LT waste heat utilisation

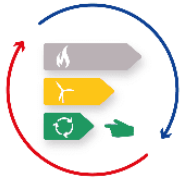
- Reduced losses
- Reduced peaks
- Resilient and flexible
- Scalable
- Full electric

5GDHC: self-regulating loops

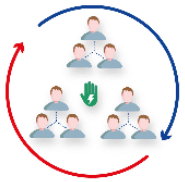


5 principles to define 5GDHC

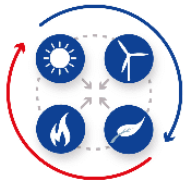
1. Closing the energy loop
An optimized system allowing exchange of heat and cold between end users.



2. Using low-grade sources for low-grade demand
In 5GDHC we match the supply with the requested quality level of the demand.



3. Decentralized & demand-driven energy supply
Circulating energy within the system only when and where needed, as close as possible to the end-user



4. An integrated approach of energy flows
Connecting heating and cooling to other energy flows (power grid, hydrogen conversion, solar plants, etc.) to avoid energy waste across sectors and reduce peak loads.

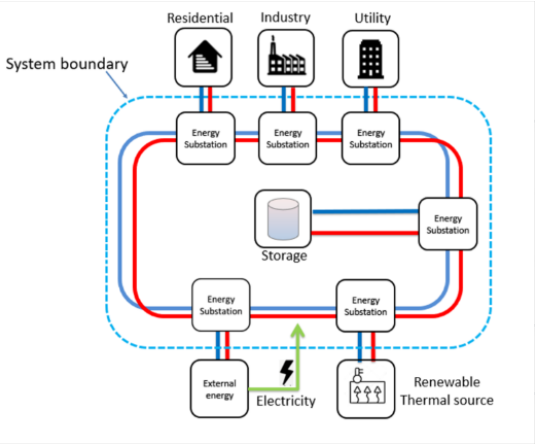
5. Local sources as a priority
Avoiding big investments and energy loss during transport, while stimulating the local economy.

5GDHC: Assessment

Principles

1. Closing the energy loop
2. `Low-graded sources for low-graded demand
3. Decentralized & demand-driven energy supply
4. An integrated approach of energy flows
5. Local sources as a priority

System boundary



KPI's

- Eext = f(Eref) ..... 100% ..... 20% ..... -10%
- Etot = a*Ehh + b*Eh + c*E0 + ... k*Ell
- Eext = f(D=0)
- E,ext,peak = f(Eaverage)
- Etot = a*E10km +b*E50km + c*E250km +d*Eglobal

Improvement options

- Technology guidelines
- Datamining and analysis
- Smart control
- Key features....

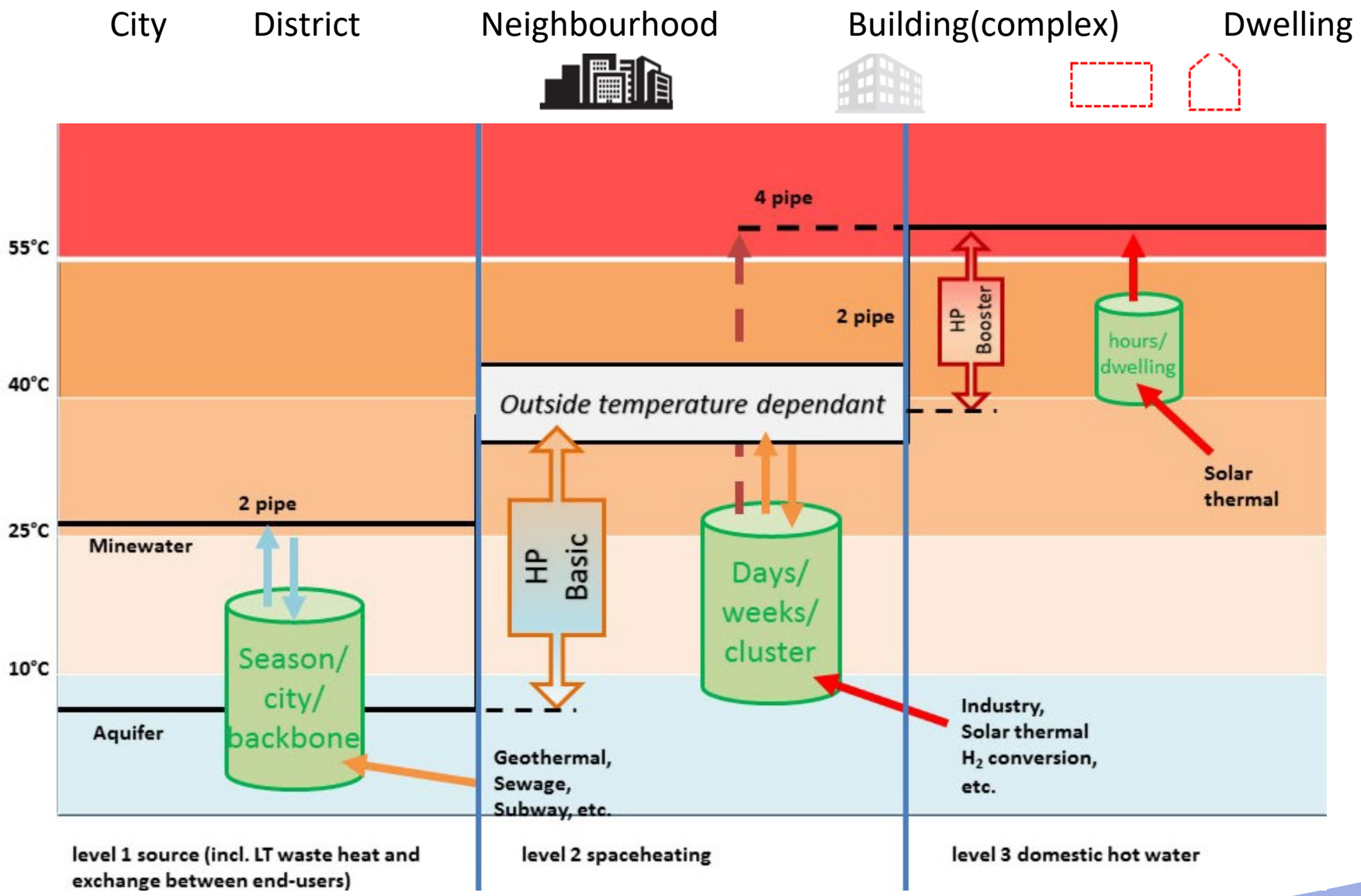
like multilevel storage, multisource,

weighfactor

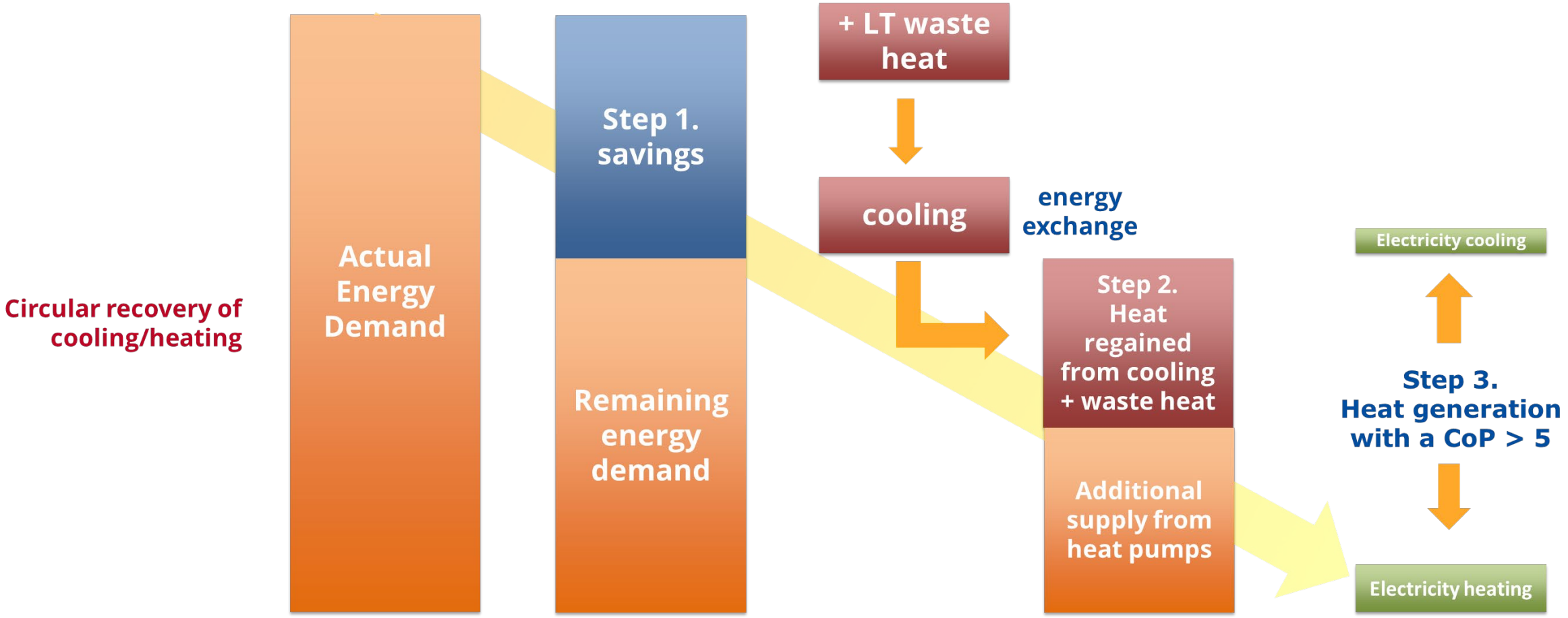
- 25%
- 30%
- 10%
- 20%
- 15%

5gDHC label

A multi level green resource and storage concept



The power of reduction

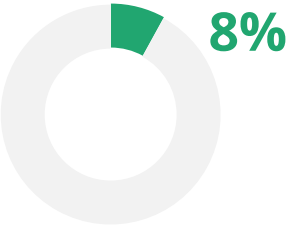


5GDHC is one of the less-emitting H&C solutions

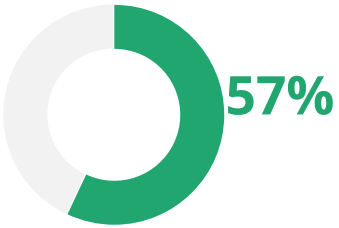
Example of Heerlen, the Netherlands
1st 5GDHC grid

Renewable and heat recovery sources

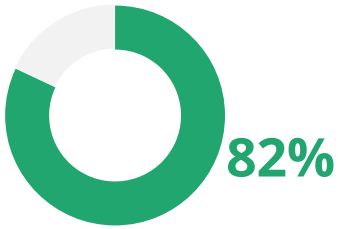
Heating and cooling in NWE



District Heating grid



5GDHC (Heerlen example)

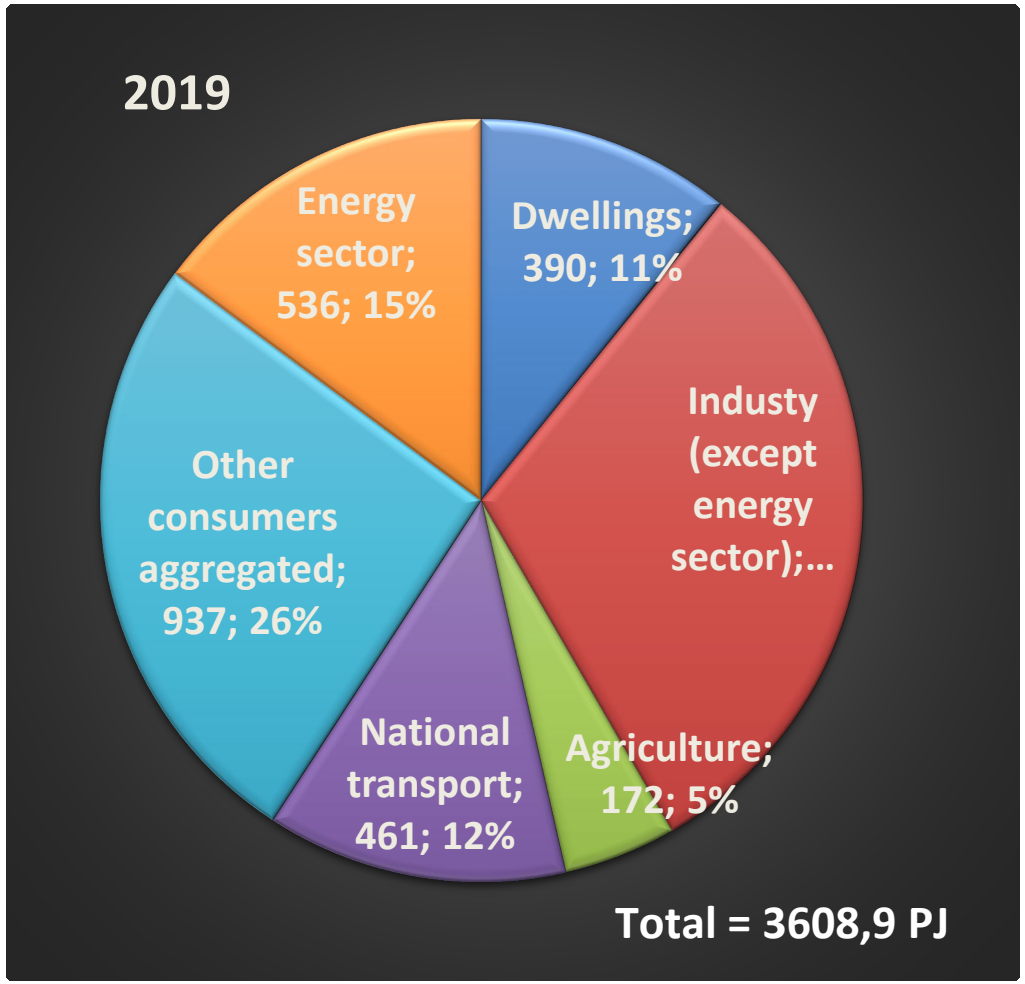


Carbon intensity of heating and cooling

Heating solutions	Carbon intensity
Gas (EU)	244 kg CO2eq/MWh
Electricity (EU)	270 kg CO2eq/MWh
District Heating grid	~120 kg CO2eq/MWh
5GDHC (Heerlen example)	92 kg CO2eq/MWh

÷ 2,7

5GDHC next steps



There is a lot of attention for energy saving in buildings ....

- At what costs
- At what time span ?
- At how much resistance ??

The new TRIAS ENERGETICA

1. Lower heating supply temperatures
2. Reduce maximum power
3. Save energy

No longer talk about "AFFORDABLE" and "ACCEPTABLE"

The key for future steps is: Faster, Faster, Faster.

HOW ?

- Plug & play,
- Foolproof,
- Smart.

Q&A

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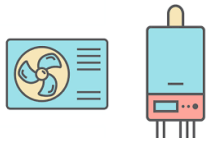
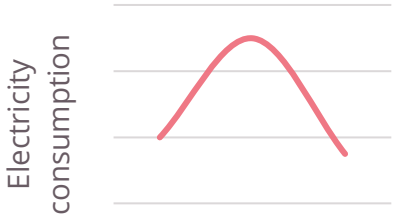
A need to avoid electricity peak consumption and to protect from energy price rise

Principle 2
Using low-graded sources



Need for heatpumps

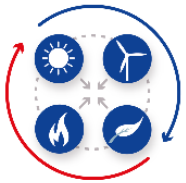


Peak loads

Use of fossil fuels

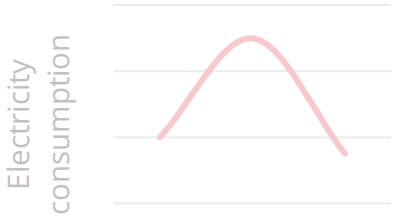
A need to avoid electricity peak consumption

Principle 2
Using low-graded sources



Principle 4
An integrated approach of energy flows

Need for heatpumps



Peak loads

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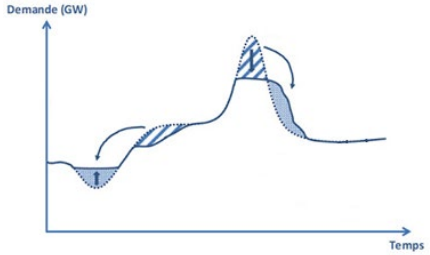

1. Using thermal storage to reduce peak loads
2. Advanced demand-side management to shift peak loads
3. Producing its own electricity

Having an integrated approach of energy consumption to reduce GHG emissions and energy costs

#2

CREATE A LOCAL ENERGY COMMUNITY WITH LOW CARBON EMISSIONS

- Carbon intensity reduced at its lowest for a sustainable quality of service
- Making consumers become prosumers furthermore

#1

HAVE A COMPLETE AND HOLISTIC VIEW OF ENERGY CONSUMPTION AT A TERRITORY SCALE

- Include the best practices for production, distribution, storage, and management of local renewable electricity in 5GDHC grids

#3

CURB ENERGY COSTS ON THE LONG-TERM

- Investments that provide a long-term visibility
- Protect the territory community from costs evolution

Benefitting from the best practices for production, distribution, storage, and management of local renewable electricity

SOLAR ENERGY SOLUTIONS

Power-to-heat: Self-produced renewable electricity to provide electricity:

- To electric installations of the 5G grid (heat pumps)
- To other consumers of the district: housings, stores, electric mobility, etc.

Thermal/ PVT hybrid solar panels to produce domestic hot water in complementarity with heating from the grid

STORAGE FACILITIES

Optimizing the local use of the energy produced and distribution to other consumers and producers through storage:

- Thermal storage
- Electric storage

SMART MONITORING & CONTROL

intelligent and real time balance between demand and supply to allow for various operational models:

- Providing green electricity to the thermal grid, to other consumers
- Selling surplus energy to electricity grid operators
- Storing energy to balance fluctuations

Developing financing, contracting, pricing and governance models

#1
FINANCING

Managing the financing of the energy production, distribution, storage and consumption in multiple ways:

- Energy produced, owned or stored by the grid owner/manager
- Energy produced, owned, bought or sold by a client of the DHC
- Third party financing

#2
CONTRACTING & GOVERNANCE

Managing the distribution of energy locally produced (and its associated services) among users for shared benefice:

- The DHC grid
- District buildings
- Households
- Other (Electric mobility, etc.)
- Electric grid

#3
REVENUES & PRICING

- Studying the economies made by DHC operator
- Studying the electricity price for consumers and electric grid operator:
  - Same price for all
  - “Social electricity price”: lower price for social housings families, higher for other consumers

Pilot sites from D2Grids are studying different models to share feedbacks and spread best practices

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Case-study: DHC grid & solar in Sweden

PARIS-SACLAY PILOT SITE – COLLECTIVE SELF-CONSUMPTION PHOTOVOLTAICS

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European Regional Development Fund

celsius

Lucas Lazzarini

Energy Engineer

Seqens
Groupe ActionLogement

@D2Grids #5GDHC

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BRUNSSUM PILOT SITE – ABOUT THE 5GDHC GRID

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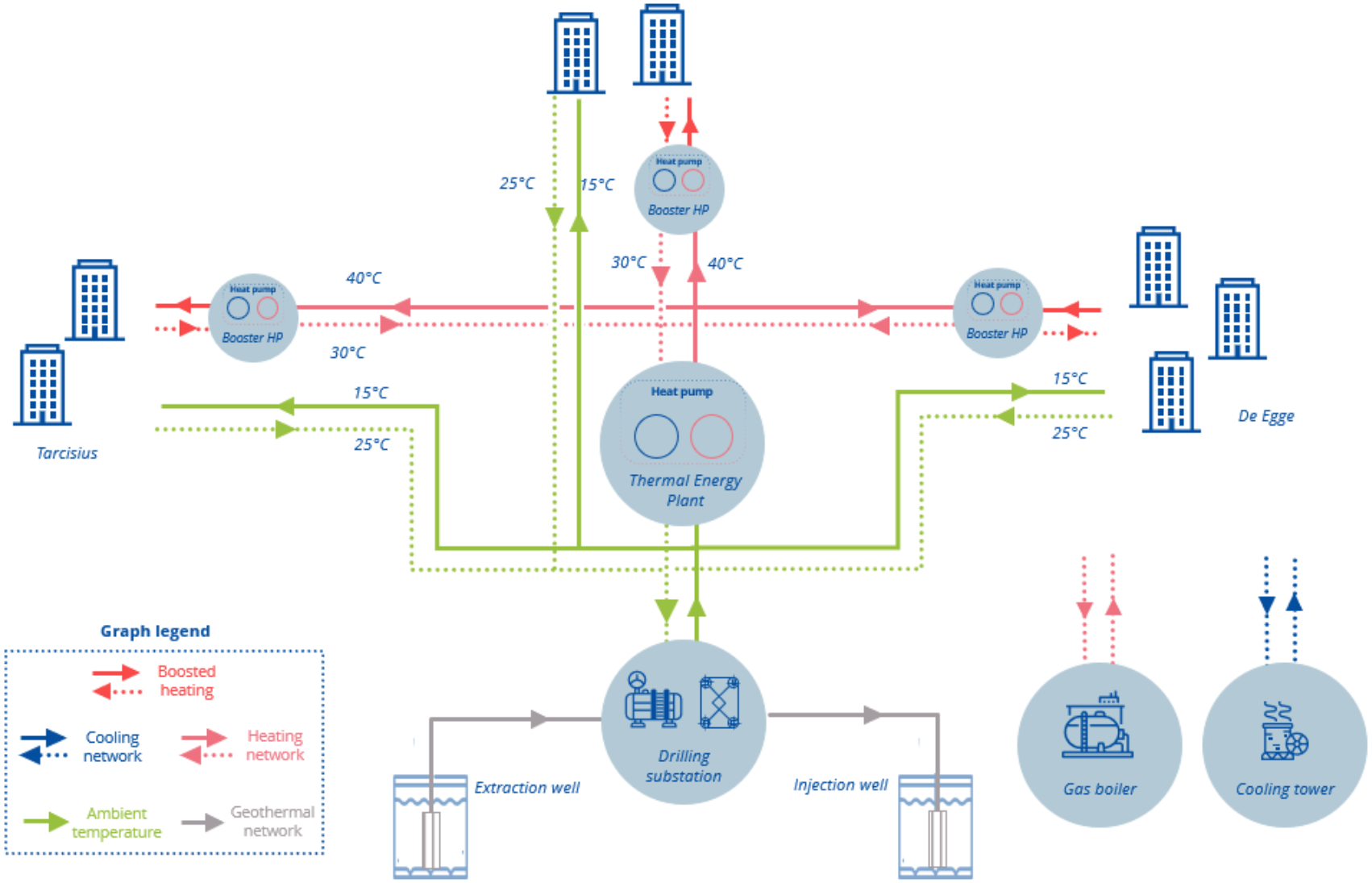
Brunssum scheme



PLYMOUTH PILOT SITE – PLANS FOR PV PANELS

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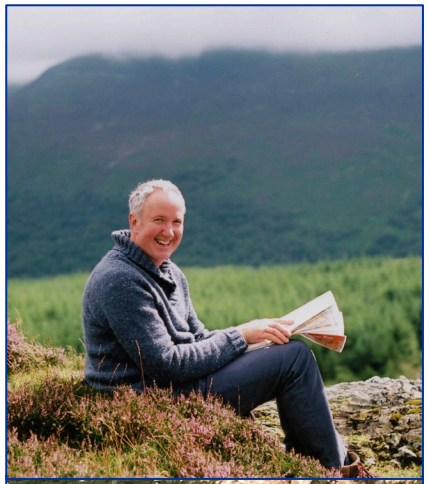


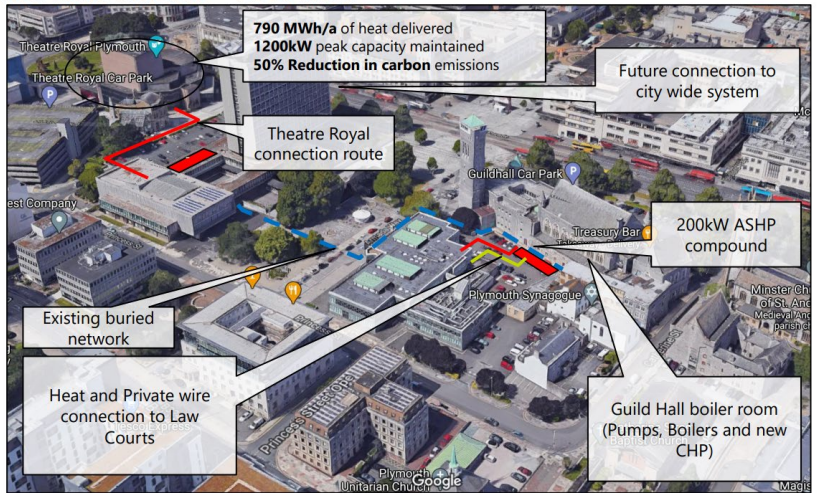
Jon Selman
Alastair Gets

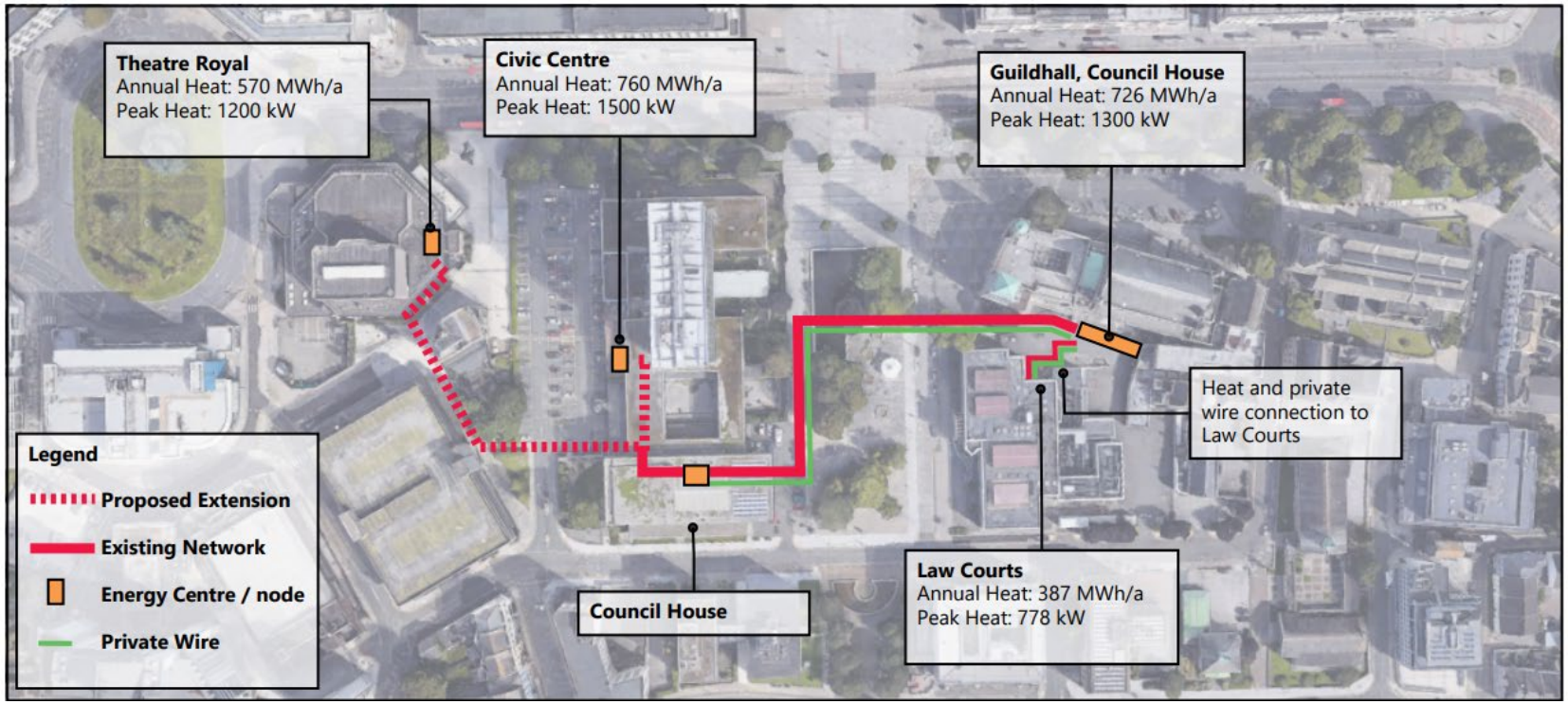
Low Carbon City Officers

PLYMOUTH CITY COUNCIL

Guildhall Cluster- private wire serving Heat Pumps with Solar and storage

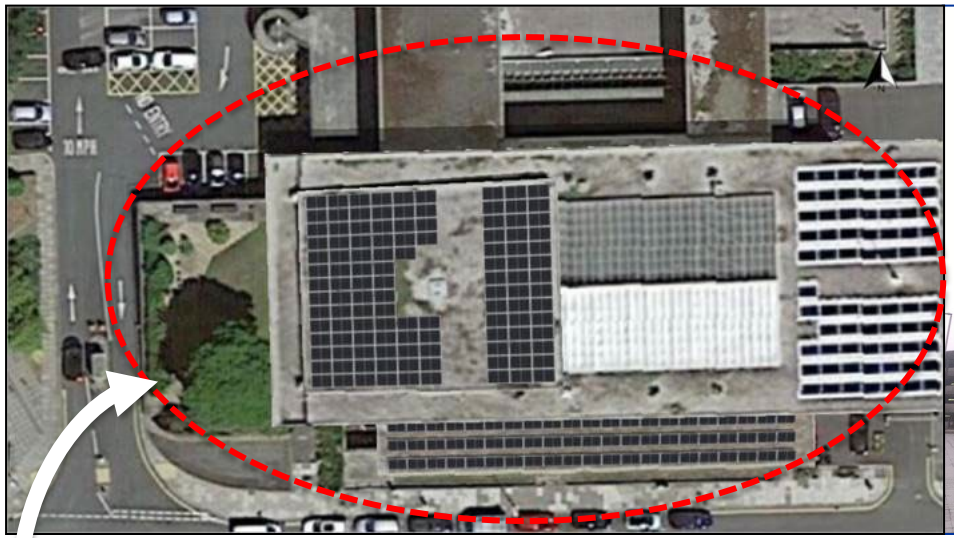
Guild Hall Cluster - overview



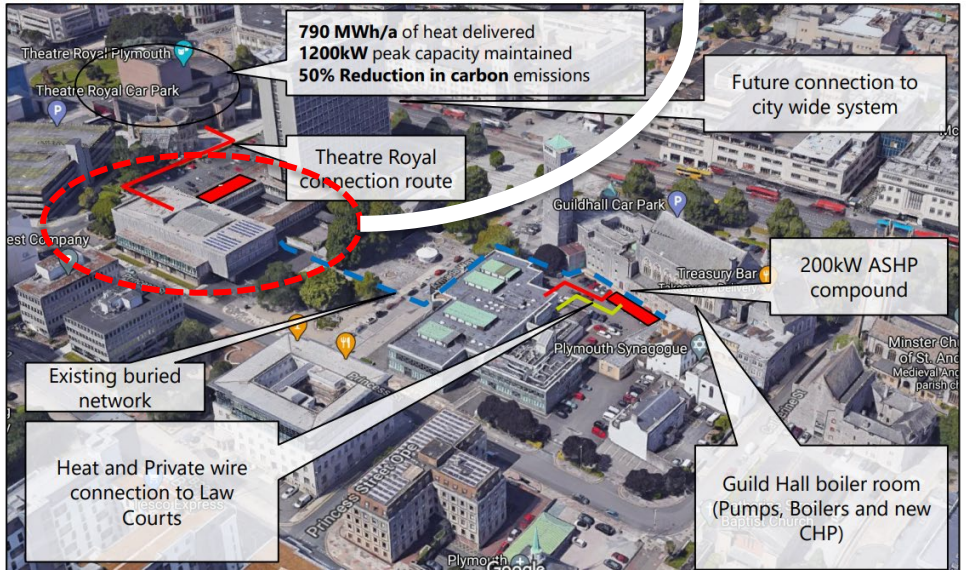


Guildhall Cluster- private wire serving Heat Pumps with Solar and storage

Phase 1: Solar



Guild Hall Cluster - overview



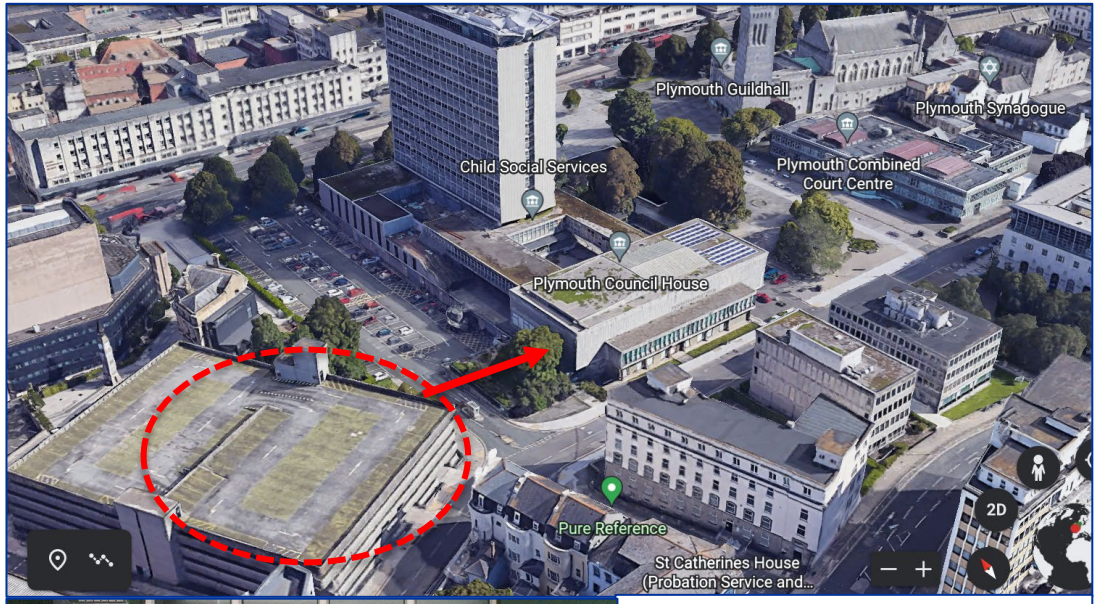
- Council House solar 90kWp generating about 85MWh/y
- Guildhall ASHP is 196kW generating drawing 479MWh/y of heat, and drawing 191MWh/y of electricity.
- CHP generates 435MWh/y of heat and generates 234MWh/y of electricity

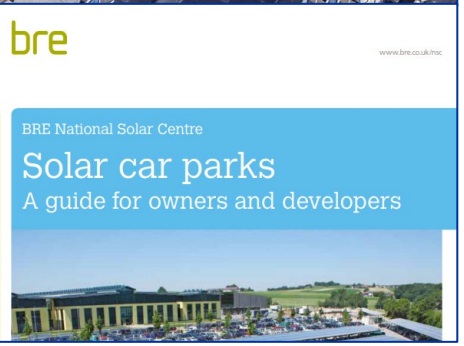
Guildhall Cluster- private wire serving Heat Pumps with Solar and storage

Phase 2: Extra Solar & Storage

Private Wire: having multiple demand (including **heat pumps**) balanced with **CHP, solar and batteries** makes for well distributed local network that relies less on the grid.

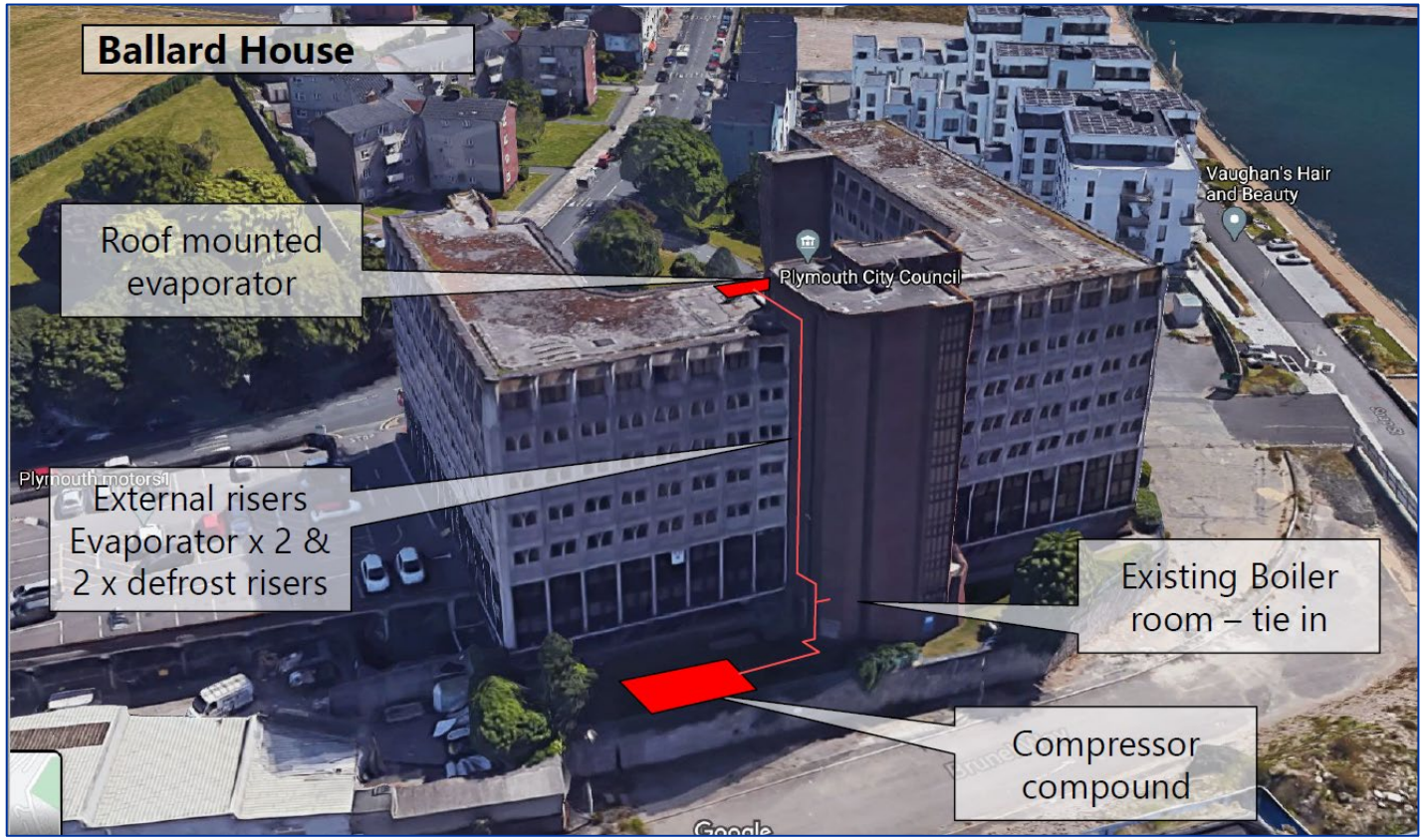
Batteries help smooth the generation peaks with the time-offset demand peaks – ie. when the sun is shining the heating may be less but it can be stored to be used when the sun goes down and more heating needed





Ballard House Solar alongside Heat Pump.

- ASHP is 196kW generating 608MWh/y of heat, and drawing 216MWh/y.
- ASHP also water source for future connection to heat network
- Solar is 64kWp generating 61MWh/y (but mostly in summer)
- Insulation reduces the heat needed by 99MWh/y (mostly winter)



BRUNSSUM PILOT SITE – FEASIBILITY STUDY FOR PV PANELS

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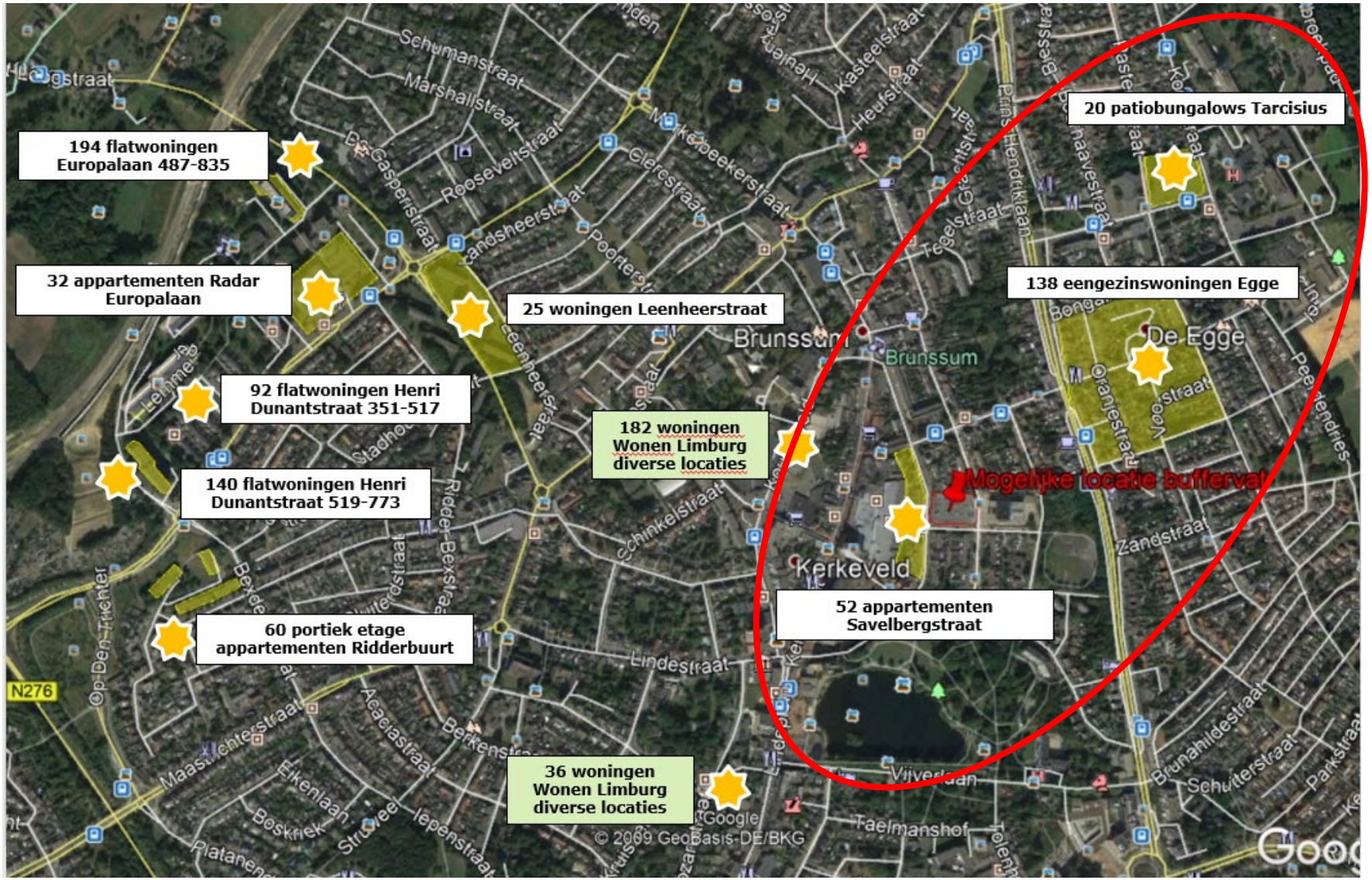
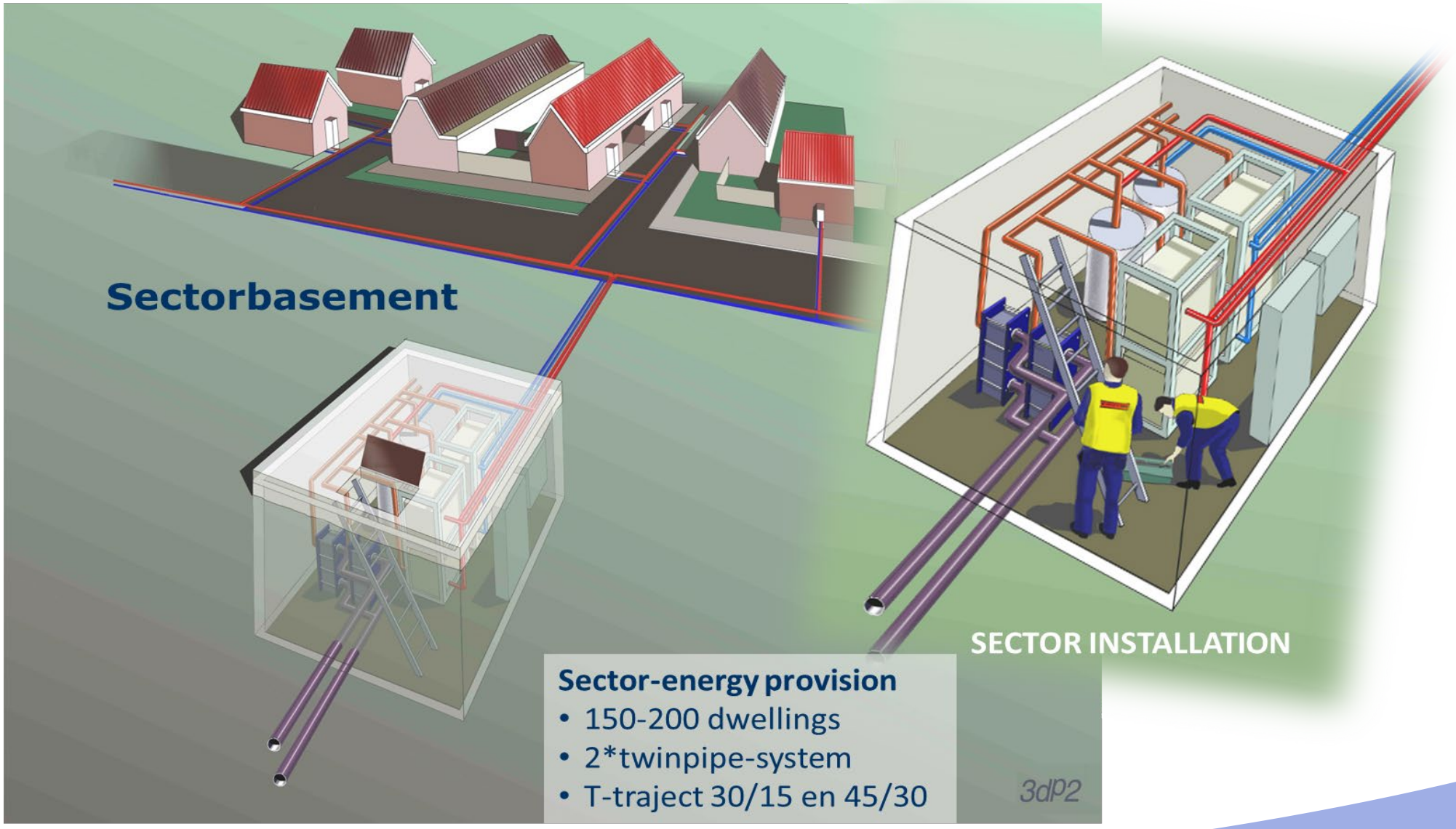
Brunssum Plan Gasfree Districts



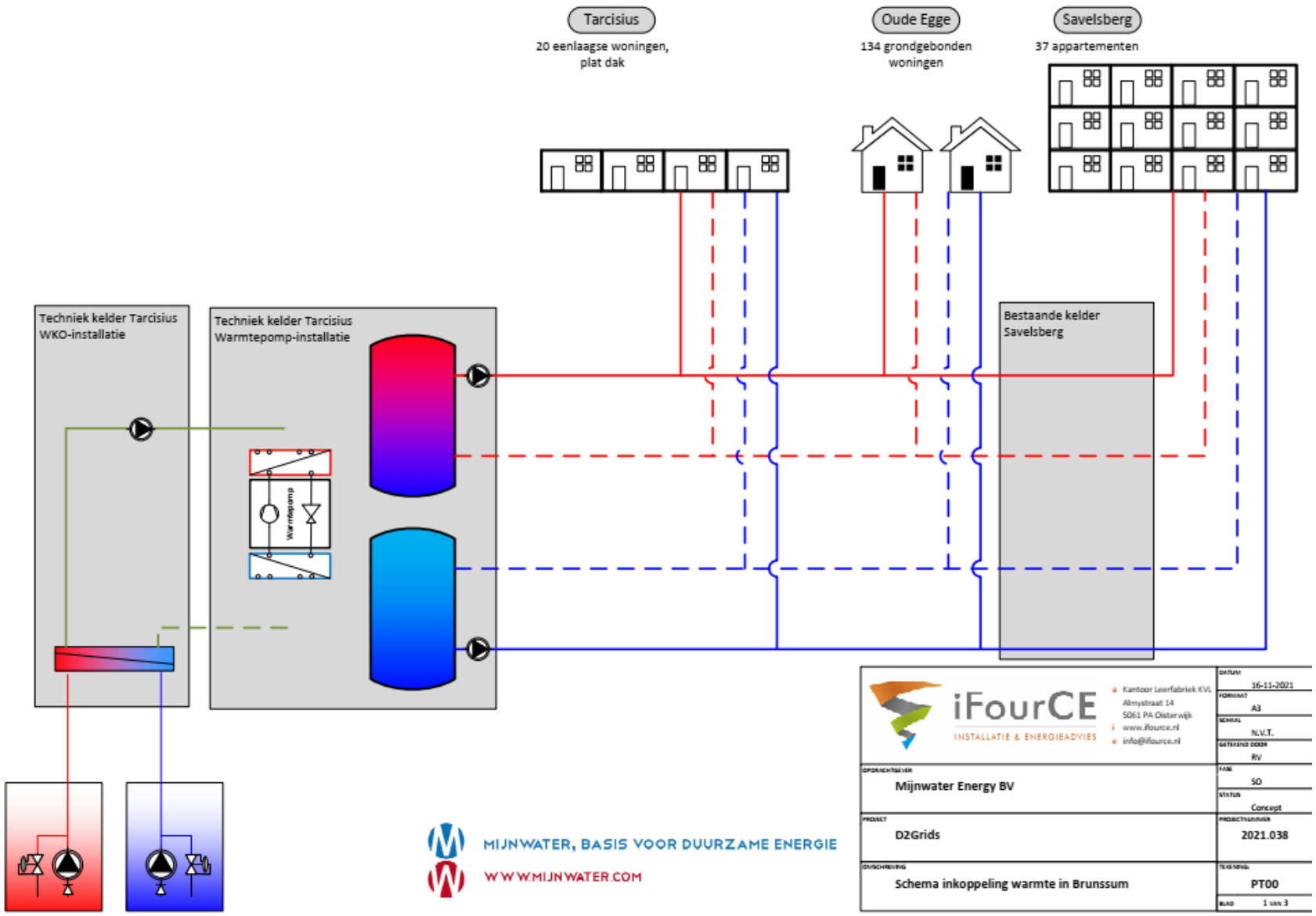
Subsoil District Energy Plant



Subsoil District Energy Plant

Subsoil District Energy Plant

Brunssum scheme



Brunssum connected houses

Sint Gregoriuslaan Brunssum 20 Home-Care houses

Demolishment and rebuilt of 130 mineworker houses and 10 apartments

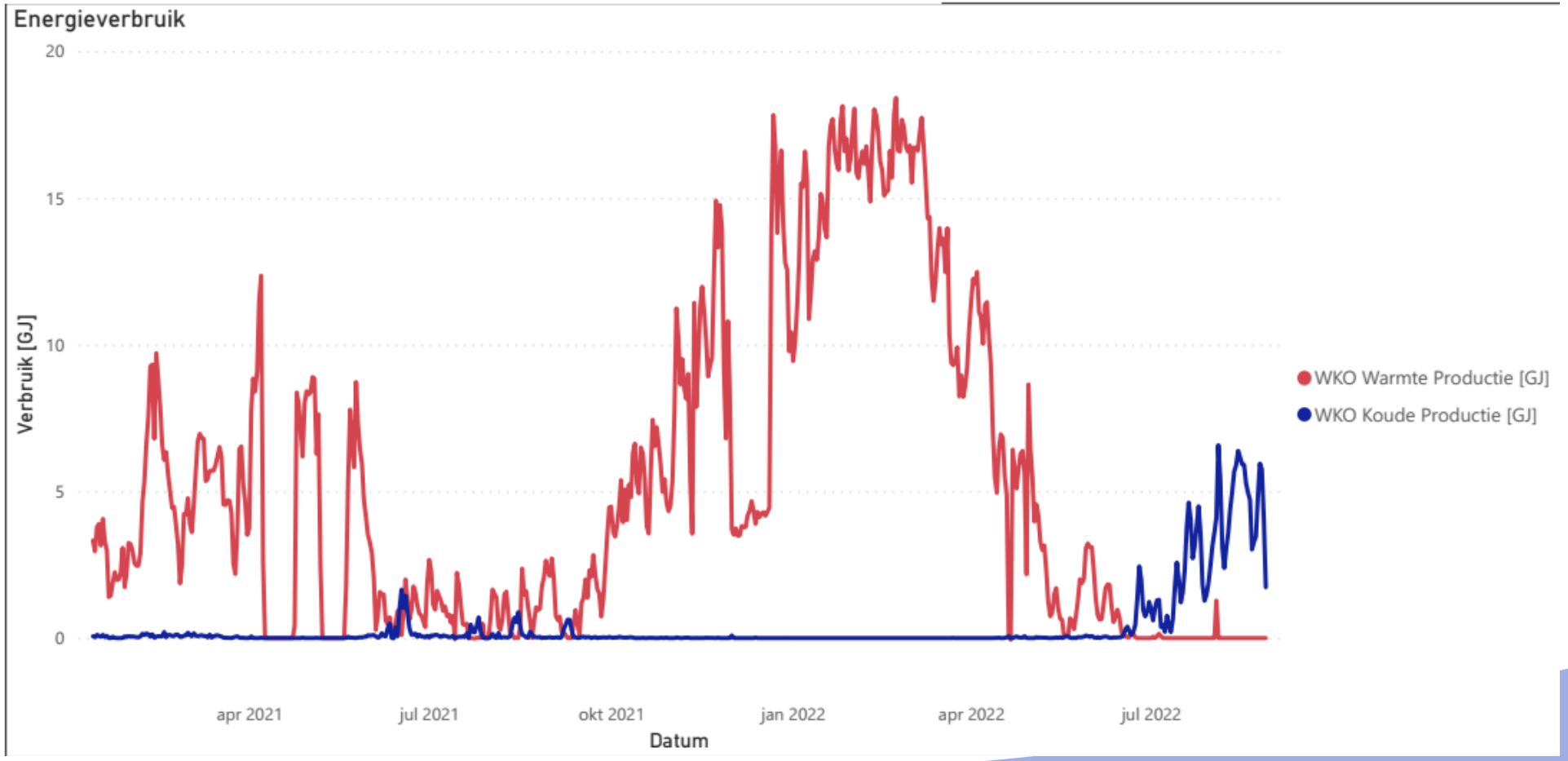
50 apartments Pastoor Savelbergstraat Brunssum

17 apartments
Europalaan
Brunssum-Noord

Brunssum Energy Consumption Aquifer

- Energieproductie WKO bepaald op basis van flow en temperatuurverschil
- Voorwaarde bepaling voor koeling of verwarming gebaseerd op temperatuurverschil secundaire transportpompen.
- Egge fase 1 oplevering c.a. 1-07-21 (52 woningen)
- Egge fase 2a oplevering c.a. 15-04-21 (44 woningen)
- Egge fase 2b oplevering c.a. Q1 2023 (38 woningen)

Warmte	Koude
3.038	224
WKO Warmte Productie [GJ]	WKO Koude Productie [GJ]



Brunssum Energy Consumption System

Power demand	heat	cold	
Tarcisius	68 kW	22 kW	
De oude Egge	482 kW	196 kW	
Past Savelbergstraat	152 kW	82 kW	
Total (kW) ca.	700 kW	300 kW	
Energy demand	**Space heating**	**Domestic hot water**	**Space Cooling**
Tarcisius	240 GJ /a	80 GJ /a	60 GJ /a
De oude Egge	2.010 GJ /a	1.072 GJ /a	503 GJ /a
Past Savelbergstraat Fase 1	444 GJ/a	222 GJ /a	111 GJ /a
Total (kW) ca.	2.700 GJ /a	1.375 GJ /a	675 GJ /a

Brunssum Energy Consumption System

MINEWATER SYSTEM BRUNSSUM — WELLS (WKO)

	TOTAL HEATING DEMAND [GJ]	TOTAL COOLING DEMAND [GJ]	COP ES HEATING [-]	COP ES COOLING (passive) [-]	ENERGY LOSS HEAT (network) [GJ]	WKO HEAT [GJ]	WKO COLD [GJ]	REGEN. DEMAND (injection) [GJ]	EMISSION CO2 [kg CO2]	*CO2 reduction*
2022	2.797	257	4,3	52,0	420	2.098	226	4.412	86.034	*45%*
2023	3.392	420	4,3	52,0	509	2.290	370	4.191	78.555	*59%*
2024	3.392	500	4,3	52,0	509	2.335	440	3.982	72.801	*63%*
2025	3.392	550	4,4	52,0	509	2.382	484	2.908	59.765	*70%*
2026	3.392	550	4,4	52,0	509	2.430	484	2.908	59.765	*70%*
2027	3.392	550	4,5	52,0	509	2.478	484	2.908	59.765	*70%*
2028	3.392	550	4,5	52,0	509	2.516	484	2.908	59.765	*70%*
2029	3.392	550	4,5	52,0	509	2.553	484	2.908	59.765	*70%*
2030	3.392	550	4,6	52,0	509	2.579	484	2.908	59.765	*70%*

TRADITIONAL — TRADITIONAL HEATING / TRADITIONAL COOLING

	CALORIC ENERGY GAS [m3/GJ]	GAS USAGE HEATING [m3]	EMISSION HEATING [kg/m3]	EMISSION CO2 [kg CO2]	E,el COOLING MACHINE [kWh]	EMISSION E,el [kg/kWh]	EMISSION CO2 [kg CO2]	EMISSION CO2 [kg CO2]
2022	31,6	81.654	1,78	145.345	28.012	0,370	10.364	155.709
2023	31,6	99.017	1,78	176.250	45.733	0,370	16.921	193.172
2024	31,6	99.017	1,78	176.250	54.444	0,370	20.144	196.395
2025	31,6	99.017	1,78	176.250	59.889	0,370	22.159	198.409
2026	31,6	99.017	1,78	176.250	59.889	0,370	22.159	198.409
2027	31,6	99.017	1,78	176.250	59.889	0,370	22.159	198.409
2028	31,6	99.017	1,78	176.250	59.889	0,370	22.159	198.409
2029	31,6	99.017	1,78	176.250	59.889	0,370	22.159	198.409
2030	31,6	99.017	1,78	176.250	59.889	0,370	22.159	198.409

Solution directions are:

1. Sun PVT panels 1.375 m^2 on Tarcisius 0,4 kW/m^2 => 550 kW / 3.715 GJ, Investment M€ 1,325
2. Heat pipes 800 m^2 on Tarcisius 0,4 kW/m^2 => 320 kW / 1.600 GJ, Investment M€ 1,000 excl. VAT
3. Dry Cooler on Tarcisius => 375 kW / 1.000 GJ at Tair = 12/18 C, Investment M€ 0,450 excl. VAT
4. Asphalt collector 4.000 m^2 0,035 kW/m^2 => 140 kW / 2.000 GJ, Investment M€ 0,950 excl. VAT
5. Combination between 1 and 2 Tarcisius => 320 kW / 2.980 GJ, Investment M€ 1,2000 excl. VAT
6. Combination between 1 and 3 Tarcisius => 535 kW / 2.080 GJ, Investment M€ 1,2000 excl. VAT

Option 6. is advised, with additional benefits:

- No noise production
- Energy balance is adjustable by turning / switching off the heat pipes
- Lower investment compared to option 1
- Provides electricity which can be used by the EC
- Opportunities for additional subsidies

Q&A

Agenda

What is 5th generation of district heating and cooling?

How can solar, and in particular PV be used in these grids?

Round table of the pilot sites of D2Grids

Case-study: DHC grid & solar in Sweden

CITY OF GOTHENBURG
PUBLIC HOUSING COMPANY GROUP FRAMTIDEN
SOLAR ENERGY & DISTRICT HEATING

Nina Jacobsson Stålheim

Head of sustainability

Framtiden

Framtiden Company group:

The City of Gothenburg's Public Housing Group

75.000 apartments

25% of the citizens in Gothenburg live in a rental flat owned by Framtiden

Energy use & production:

80% district heating

20% electricity

Installed PV capacity today: approx. 10,000 kW_p



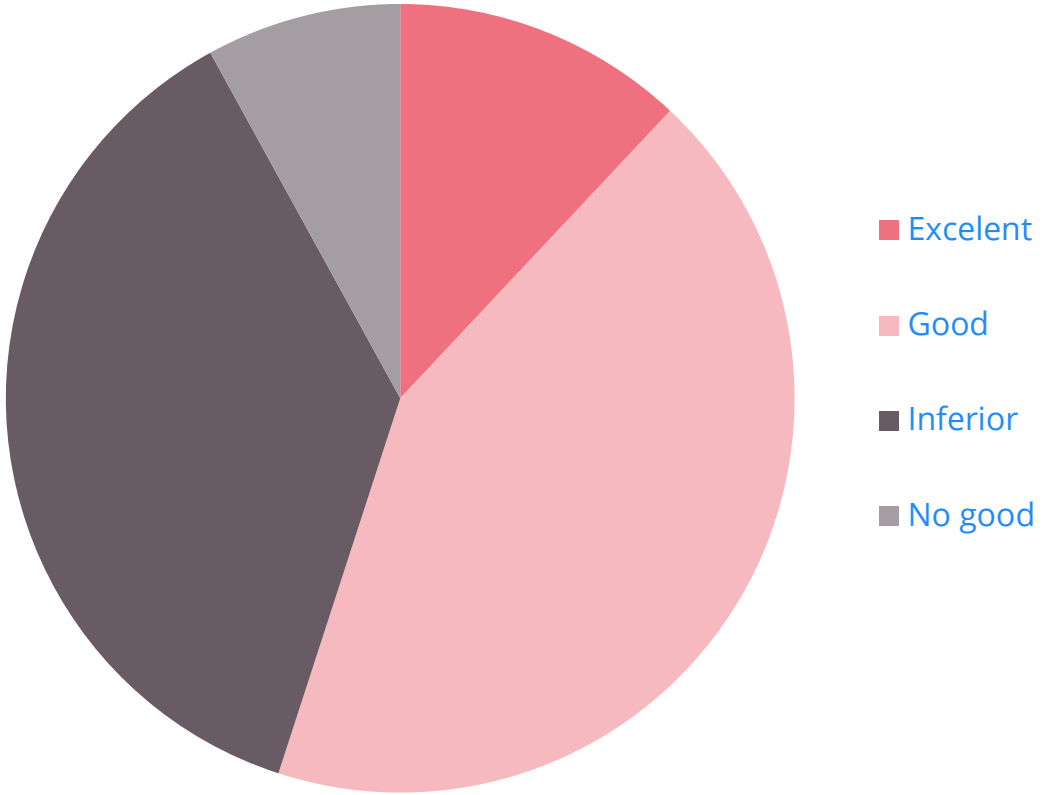

Solar Energy Plan for Framtiden:

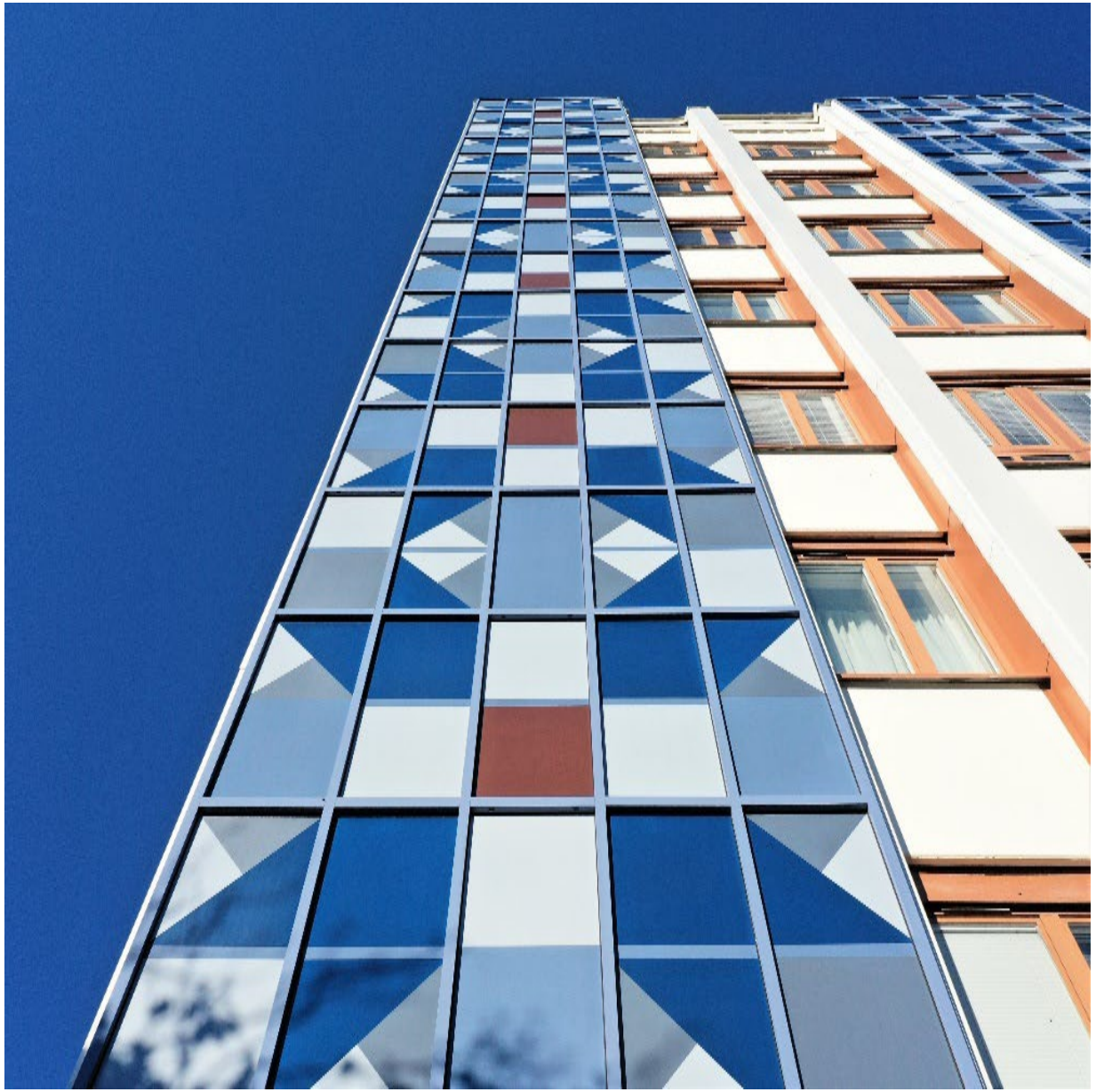
- Contribute to the overall goal of the City having a net zero carbon footprint by 2030 and a higher degree of local renewable production of electricity
- Reduce Framtiden's climate impact
- Reduce the amount of purchased electricity

Solar Energy Plan for Framtiden:

- Use <u>all</u> roofs suited for PV systems to a maximum by 2030
- The plan therefore steers towards electricity production that may momentarily exceed the property's electricity need, i.e. we sell electricity
- Includes both existing and new buildings

Conditions for solar panels on existing buildings

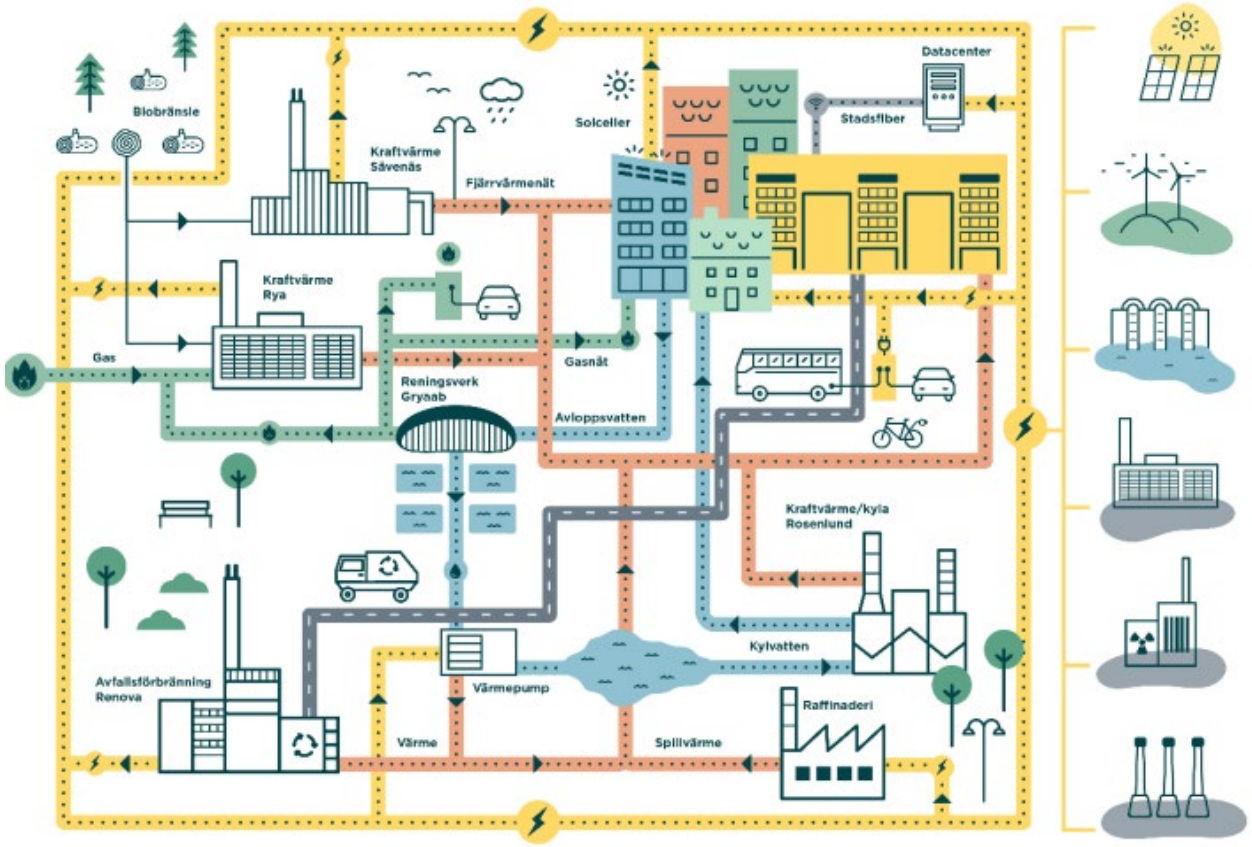




Solar Energy Plan for Framtiden:

2023-2030:

- 26,000 kWp capacity will be installed on existing buildings
- 8,000 kWp capacity will be installed on new buildings
- Calculated to be a good return of investment



Energy Plan for the City of Gothenburg 2022-2030

Investigate:

- Vehicle to grid
- Energy storage
- PED
- etc

Thank you!

nweurope.eu/D2grids

paul.capgras@construction21.fr

@D2Grids

D2Grids

www.celsiuscity.eu

Celsius@johannebergsciencepark.com

@celsiuscity

Celsius Initiative