Renewable electricity in 5GDHC

DECARBONISING EUROPEAN CITIES
Mathilde Henry
Consulting Project Manager in energy transition

Emilia Pisani
Communications Officer Moderator
The Celsius Initiative
-a demand driven collaboration hub-
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 tailor-made 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.

Looking at the big picture to identify and address the challenging pieces.
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 adaptability and replication of 5GDHC systems.

Commercialisation:
Clarifying the business model of 5GDHC and promoting 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
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
Agenda

What is 5th generation of district heating and cooling?

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Case-study: DHC grid & solar in Sweden
Herman Eijdems
Director of Innovation

MINE WATER, A BASIS FOR SUSTAINABLE ENERGY
WWW.MJINWATER.COM
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
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
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

Improvement options
- Technology guidelines
- Datamining and analysis
- Smart control
- Key features... like multilevel storage, multisource,

System boundary

KPI’s

\[ E_{\text{ext}} = f(E_{\text{ref}}) \quad \text{...} \quad 100\% \quad \text{...} \quad 20\% \quad \text{...} \quad -10\% \]
\[ E_{\text{tot}} = a \cdot E_{\text{hh}} + b \cdot E_{\text{h}} + c \cdot E_{0} + \ldots + k \cdot E_{\text{ll}} \]
\[ E_{\text{ext}} = f(D=0) \]
\[ E_{\text{ext,peak}} = f(E_{\text{average}}) \]
\[ E_{\text{tot}} = a \cdot E_{10\text{km}} + b \cdot E_{50\text{km}} + c \cdot E_{250\text{km}} + d \cdot E_{\text{global}} \]

Weighfactor

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

5GDHC label
A multi level green resource and storage concept

City          District              Neighbourhood Building(complex)            Dwelling

55°C

40°C

25°C

Minewater

10°C

Aquifer

Outside temperature dependant

4 pipe

2 pipe

HP Booster

Solar thermal

Days/weeks/cluster

Industry, Solar thermal H₂ conversion, etc.

level 1 source (incl. LT waste heat and exchange between end-users)

level 2 spaceheating

level 3 domestic hot water
The power of reduction

Circular recovery of cooling/heating

Actual Energy Demand

Step 1. savings

+ LT waste heat

cooling

energy exchange

Step 2. Heat regained from cooling + waste heat

Additional supply from heat pumps

Step 3. Heat generation with a CoP > 5

Electricity cooling

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

Renewable and heat recovery sources

<table>
<thead>
<tr>
<th>Heating and cooling in NWE</th>
<th>District Heating grid</th>
<th>5GDHC (Heerlen example)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8%</td>
<td>57%</td>
<td>82%</td>
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Carbon intensity of heating and cooling

<table>
<thead>
<tr>
<th>Heating solutions</th>
<th>Carbon intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas (EU)</td>
<td>244 kg CO2eq/MWh</td>
</tr>
<tr>
<td>Electricity (EU)</td>
<td>270 kg CO2eq/MWh</td>
</tr>
<tr>
<td>District Heating grid</td>
<td>~120 kg CO2eq/MWh</td>
</tr>
<tr>
<td>5GDHC (Heerlen example)</td>
<td>92 kg CO2eq/MWh</td>
</tr>
</tbody>
</table>

\[ \frac{244}{92} = 2.7 \]
5GDHC next steps

There is a lot of attention for energy saving in buildings ....
1. At what costs
2. At what time span ?
3. 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 ?
1. Plug & play,
2. Foolproof,
3. Smart.
Q&A
Agenda

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

Round table of the pilot sites of D2Grids

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Mathilde Henry
Consulting Project Manager in energy transition

GreenFlex
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

- Need for heat pumps
- Peak loads
- Use of fossil fuels

**Principle 4**
An integrated approach of energy flows

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

#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

#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

#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

<table>
<thead>
<tr>
<th>#1</th>
<th>FINANCING</th>
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<tbody>
<tr>
<td>Managing the financing of the energy production, distribution, storage and consumption in multiple ways:</td>
<td></td>
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<tr>
<td>• Energy produced, owned or stored by the grid owner/manager</td>
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<tr>
<td>• Energy produced, owned, bought or sold by a client of the DHC</td>
<td></td>
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<tr>
<td>• Third party financing</td>
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</table>

<table>
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<tr>
<th>#2</th>
<th>CONTRACTING &amp; GOVERNANCE</th>
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<tbody>
<tr>
<td>Managing the distribution of energy locally produced (and its associated services) among users for shared benefit:</td>
<td></td>
</tr>
<tr>
<td>• The DHC grid</td>
<td></td>
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<tr>
<td>• District buildings</td>
<td></td>
</tr>
<tr>
<td>• Households</td>
<td></td>
</tr>
<tr>
<td>• Other (Electric mobility, etc.)</td>
<td></td>
</tr>
<tr>
<td>• Electric grid</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>#3</th>
<th>REVENUES &amp; PRICING</th>
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</thead>
<tbody>
<tr>
<td>- Studying the economies made by DHC operator</td>
<td></td>
</tr>
<tr>
<td>- Studying the electricity price for consumers and electric grid operator:</td>
<td></td>
</tr>
<tr>
<td>• Same price for all</td>
<td></td>
</tr>
<tr>
<td>• “Social electricity price”: lower price for social housings families, higher for other consumers</td>
<td></td>
</tr>
</tbody>
</table>

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

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Case-study: DHC grid & solar in Sweden
PARIS-SACLAY PILOT SITE – COLLECTIVE SELF-CONSUMPTION PHOTOVOLTAICS
BRUNSSUM PILOT SITE – ABOUT THE 5GDHC GRID
Herman Eijdems
Director of Innovation
PLYMOUTH PILOT SITE – PLANS FOR PV PANELS
Jon Selman
Alastair Gets
Low Carbon City Officers
Guildhall Cluster- private wire serving Heat Pumps with Solar and storage
Guildhall Cluster: private wire serving Heat Pumps with Solar and storage

Phase 1: Solar

- 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
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
Herman Eijdems
Director of Innovation
Brunssum Plan Gasfree Districts

- 194 flatwoningen Europalaan 487-835
- 32 appartementen Radar Europalaan
- 92 flatwoningen Henri Dunontstraat 351-517
- 140 flatwoningen Henri Dunontstraat 519-773
- 60 portiek etage appartementen Bildertuurt
- 25 woningen Leenheerstraat
- 138 eengezinswoningen Egge
- 182 woningen Wonen Limburg diverse locaties
- 20 patio-bungalows Tarcisius
- 52 appartementen Savellbergstraat
- 36 woningen Wonen Limburg diverse locaties
Subsoil District Energy Plant

Sector-energy provision
- 150-200 dwellings
- 2*twinpipe-system
- T-traject 30/15 en 45/30
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
- 17 apartments Europalaan Brunssum-Noord
- 50 apartments Pastoor Savelbergstraat Brunssum
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)

<table>
<thead>
<tr>
<th>Warmte</th>
<th>Koude</th>
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<tr>
<td>3.038</td>
<td>224</td>
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<tr>
<td>WKO Warmte Productie [GJ]</td>
<td>WKO Koude Productie [GJ]</td>
</tr>
</tbody>
</table>

Energieverbruik

- Verbruik [GJ]
- Datum: apr 2021, jul 2021, okt 2021, jan 2022, apr 2022, jul 2022

WKO Warmte Productie [GJ]
WKO Koude Productie [GJ]
# Brunssum Energy Consumption System

<table>
<thead>
<tr>
<th>Power demand</th>
<th>heat</th>
<th>cold</th>
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<tbody>
<tr>
<td>Tarcisius</td>
<td>68 kW</td>
<td>22 kW</td>
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<tr>
<td>De oude Egge</td>
<td>482 kW</td>
<td>196 kW</td>
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<tr>
<td>Past Savelbergstraat</td>
<td>152 kW</td>
<td>82 kW</td>
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<tr>
<td>Total (kW) ca.</td>
<td>700 kW</td>
<td>300 kW</td>
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<table>
<thead>
<tr>
<th>Energy demand</th>
<th>Space heating</th>
<th>Domestic hot water</th>
<th>Space Cooling</th>
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<tr>
<td>Tarcisius</td>
<td>240 GJ /a</td>
<td>80 GJ /a</td>
<td>60 GJ /a</td>
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<tr>
<td>De oude Egge</td>
<td>2.010 GJ /a</td>
<td>1.072 GJ /a</td>
<td>503 GJ /a</td>
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<tr>
<td>Past Savelbergstraat Fase 1</td>
<td>444 GJ/a</td>
<td>222 GJ /a</td>
<td>111 GJ /a</td>
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<tr>
<td>Total (kW) ca.</td>
<td>2.700 GJ /a</td>
<td>1.375 GJ /a</td>
<td>675 GJ /a</td>
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</table>
## Brunssum Energy Consumption System

### MINEWATER SYSTEM BRUNSSUM

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<td>257</td>
<td>4,3</td>
<td>52,0</td>
<td>420</td>
<td>2.098</td>
<td>226</td>
<td>4.412</td>
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<td>420</td>
<td>4,3</td>
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<td>2.290</td>
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<td>4.191</td>
<td>78.555</td>
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<td>2024</td>
<td>3.392</td>
<td>500</td>
<td>4,3</td>
<td>52,0</td>
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<td>2.335</td>
<td>440</td>
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<td>550</td>
<td>4,4</td>
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<td>2.382</td>
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<td>4,4</td>
<td>52,0</td>
<td>509</td>
<td>2.430</td>
<td>484</td>
<td>2.908</td>
<td>59.765</td>
<td>70%</td>
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<tr>
<td>2027</td>
<td>3.392</td>
<td>550</td>
<td>4,5</td>
<td>52,0</td>
<td>509</td>
<td>2.478</td>
<td>484</td>
<td>2.908</td>
<td>59.765</td>
<td>70%</td>
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<td>2.516</td>
<td>484</td>
<td>2.908</td>
<td>59.765</td>
<td>70%</td>
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<tr>
<td>2029</td>
<td>3.392</td>
<td>550</td>
<td>4,5</td>
<td>52,0</td>
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<td>2.553</td>
<td>484</td>
<td>2.908</td>
<td>59.765</td>
<td>70%</td>
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<tr>
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<td>550</td>
<td>4,6</td>
<td>52,0</td>
<td>509</td>
<td>2.579</td>
<td>484</td>
<td>2.908</td>
<td>59.765</td>
<td>70%</td>
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## TRADITIONAL

### TRADITIONAL HEATING

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<td>54.444</td>
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</table>
Solution directions are:

1. Sun PVT panels 1.375 m² on Tarcisius 0.4 kW/m² => 550 kW / 3.715 GJ, Investment M€ 1,325
2. Heat pipes 800 m² on Tarcisius 0.4 kW/m² => 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 m² 0.035 kW/m² => 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 all 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
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!

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