

# MAKING-CITY

## Webinar 3\_PED Calculation Methods

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LHC Groningen

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# AGENDA

- ▶ Definition of PED Boundaries
- ▶ Energy Needs
- ▶ Energy Use
- ▶ RES Production
- ▶ Energy Delivered
- ▶ Primary Energy Balance
- ▶ Energy Flow Diagrams
- ▶ Reflection

# Definition of PED Boundary in Groningen



# Definition of PED Boundary in Groningen

## ► Start idea

- Both districts change(d) the heating grid from natural gas (external input) to local heating grids

## ► Opportunity to combine new built with existing building stock to reach a PED district.

## ► Aim: Solutions transferable and should be incorporated into district energy approach.

## ► PED

- North PED: involvement of citizens is core
- Southeast PED: focus on larger buildings (offices)



# Definition of PED Boundary in Groningen

- ▶ Boundaries selected based upon opportunities in the local surroundings, hence the source of the local RES.
- ▶ Buildings selected based upon variety in building age and degree of replicability.



# Definition of PED Boundary in Groningen

## ► North PED:

- 1 office building: new, and energy positive
- 2 apartments: old (1970s), and energy intensive
- 3 demo houses: old and new, various solutions
- RES in surroundings: waste heat (data centers), solar thermal

## ► Southeast PED:

- 1 sports centre: new, and energy positive
- 1 office/apartment building: new, not energy positive
- 1 office building: old, very energy intensive
- RES in the surroundings: solar parks, solar roads, solar pontoons, other PV.



# Energy Needs in PED Boundary

- ▶ Energy calculations based on EPC values and measured values from DSO.
- ▶ Large scale solutions within PED boundaries (like solar thermal and solar parks) spread amongst the larger district. The buildings represent only a small portion of the larger district, therefore a minor percentage is allocated to the PED buildings.



# Energy Needs in PED Boundary

- ▶ Building related Energy consumption deviated from measured values

| Quintel data | TJ           | share          |
|--------------|--------------|----------------|
|              | 2015         |                |
| Cooking      | 0,26         | 1,57%          |
| Lighting     | 0,23         | 1,39%          |
| Hot water    | 2,10         | 12,71%         |
| Heat         | 11,79        | 71,41%         |
| Cooling      | 0,74         | 4,50%          |
| Appliances   | 1,39         | 8,41%          |
| <b>Total</b> | <b>16,51</b> | <b>100,00%</b> |



# Energy Needs in PED Boundary

| ENERGY NEEDS                |             |                         |   |          |   |                                  |
|-----------------------------|-------------|-------------------------|---|----------|---|----------------------------------|
| THERMAL ENERGY NEEDS        |             |                         |   |          |   |                                  |
|                             |             | Units<br>(m2 or people) |   | kWh/unit |   | GWh (divide by 10 <sup>6</sup> ) |
| buildings                   | DHW needs   | 5463                    | x | 17       | = | 0.09                             |
|                             | SH needs    | 5463                    | x | 89       | = | 0.49                             |
|                             |             |                         |   |          |   | +                                |
| Energy Academy europe       | DHW needs   | 9536                    | x | 13       | = | 0.127                            |
|                             | SH needs    | 9536                    | x | 25       | = | 0.24                             |
|                             |             |                         |   |          |   | +                                |
|                             |             |                         |   |          |   | =                                |
| Total Thermal Energy Needs  |             |                         |   |          |   | 0.951                            |
| ELECTRIC ENERGY NEEDS       |             |                         |   |          |   |                                  |
|                             |             | Units<br>(m2 or people) |   | kWh/unit |   | GWh (divide by 10 <sup>6</sup> ) |
| buildings                   | Lighting    | 5463                    | x | 15       | = | 0.08                             |
|                             | Ventilation | 5463                    | x | 7        | = | 0.04                             |
|                             |             |                         |   |          |   | +                                |
| Energy Academy europe       | Lighting    | 9536                    | x | 16       | = | 0.15                             |
|                             | Ventilation | 9536                    | x | 4        | = | 0.035                            |
|                             |             |                         |   |          |   | +                                |
|                             |             |                         |   |          |   | =                                |
| Total Electric Energy Needs |             |                         |   |          |   | 0.305                            |



Figure 29: Energy needs MAKING-CITY tables for Groningen North in GWh/year



# Energy Use in PED Boundary

- Energy needs is transformed in energy use through efficiency of the emitters (it is usually the useful output of the generation technologies)

| ENERGY USE                 |               |              |   |                           |                                  |
|----------------------------|---------------|--------------|---|---------------------------|----------------------------------|
| THERMAL ENERGY USE         |               |              |   |                           |                                  |
|                            | GWh           | Energy needs | # | Efficiency of the emitter | GWh (divide by 10 <sup>6</sup> ) |
| Mediacentrale Offices      | DHW use       | 0.03896      | # | 1                         | 0.039                            |
|                            | SH use        | 0.58         | # | 1                         | 0.58                             |
|                            | SC use        | 0.424        | # | 1                         | 0.424                            |
| Mediacentrale central hall | SH use        | 0.0036       | # | 1                         | 0.004                            |
| Powerhouse                 | DHW use       | 0.273        | # | 1                         | 0.273                            |
|                            | SH use        | 0.938        | # | 1                         | 0.94                             |
|                            | SC use        | 0.95         | # | 1                         | 0.95                             |
| Total Thermal Energy use   |               |              |   |                           | 1.563                            |
| ELECTRIC ENERGY USE        |               |              |   |                           |                                  |
|                            | GWh           | Energy needs | # | Efficiency of the emitter | GWh (divide by 10 <sup>6</sup> ) |
| Mediacentrale Offices      | Lighting      | 0.0684       | # | 1                         | 0.07                             |
|                            | Ventilation   | 0.212        | # | 1                         | 0.21                             |
|                            | SH and SC use | 0.00279      | # | 1                         | 0.03                             |
|                            | DHW use       | 0.016204     | # | 1                         | 0.02                             |
| Mediacentrale central hall | Lighting      | 0.0006       | # | 1                         | 0.00                             |
|                            | Ventilation   | 0            | # | 1                         | 0.00                             |
|                            | SH and SC use | 0.000038     | # | 1                         | 0.02                             |
|                            | DHW use       | 0            | # | 1                         | 0.00                             |
| Powerhouse                 | Lighting      | 0.0004       | # | 1                         | 0.04                             |
|                            | Ventilation   | 0.0728       | # | 1                         | 0.34                             |
|                            | SH and SC use | 0.0302       | # | 1                         | 0.03                             |
|                            | DHW use       | 0            | # | 1                         | 0.00                             |
| Sports Centre              | Lighting      | 0.000077     | # | 1                         | 0.00                             |
|                            | Ventilation   | 0.0004625    | # | 1                         | 0.03                             |
|                            | SH and SC use | 0.000000     | # | 1                         | 0.00                             |
|                            | DHW use       | 0.00000005   | # | 1                         | 0.0000                           |
| Total Electric energy use  |               |              |   |                           | 0.93                             |

Figure 32: Energy uses MAKING-CITY tables for Groningen South in GWh/year

# RES Production inside the PED

## Local generation of renewable heat and electricity Groningen South

The useful energy from renewable heat and electricity takes into consideration renewable sources in place in the PED area. For electricity these are PV panels, PVT panels, parking lot P, floating Pontoons, solar road and solar parks. RES thermal energy generation comes from geothermal district heating and PVT-H panels, and a high pressure digestion.

For heat, there is a surplus of energy to be exported outside limits. For electricity, the remaining energy has to be covered by fossil fuels or external sources.

The useful energy (output) from renewable energy sources is calculated:

|                                                              | in GWh   |            |          |         |                 | Output      |
|--------------------------------------------------------------|----------|------------|----------|---------|-----------------|-------------|
|                                                              | PV       | Geothermal | PVT_el   | PVT_th  | HighPressureDig |             |
| Mediacentrale Offices                                        | 0.17763  | 11.8723    | 0.0204   | 0.12216 |                 |             |
| Mediacentrale central hall                                   |          | 0.00       |          |         |                 |             |
| Powerhouse                                                   | 0.103562 | 11.5523    | 11.04858 |         |                 |             |
| Sports Centre                                                | 1.433301 |            | 11.04623 |         | 11.250175       |             |
| Total                                                        | 0.784493 | 15.4246    | 0.76925  | 0.12216 | 11.250175       |             |
| Total energy from RES(electric)                              |          |            |          |         |                 | = 0.101048  |
| Total energy from RES(thermal)                               |          |            |          |         |                 | = 19.79     |
| Remaining (thermal) = Total Thermal Use - Total RES Thermal  |          |            |          |         |                 | = -0.145076 |
| Remaining (Electric) = Total Thermal Use - Total RES Thermal |          |            |          |         |                 | = 0.08      |

Figure 34: RES production in MAKING-CITY tables for Groningen South in GWh/year

# Energy Delivered to the PED

- ▶ Aim of the PED: produce as much as possible from RES, the rest comes from the external grids (energy delivered)

## Energy delivered Groningen South

In Groningen South, part of the electric energy is provided by the power grid while there is a surplus of thermal energy that can be exported to the District heating network.

The delivered energy is calculated (separating streams: thermal and electricity):

|                                                  | Remaining energy | Efficiency | Delivered energy |
|--------------------------------------------------|------------------|------------|------------------|
| Last check: Any remaining energy to be covered?? |                  |            |                  |
| electr_gridnational                              | 0.00             | -          | 0.00             |
| DH_national_w.                                   | -0.249           |            | -0.25            |

Figure 36: Energy delivered in MAKING-CITY tables for Groningen South in GWh/year



# Primary Energy Balance

## Primary energy balance Groningen South

PED is achieved. Primary Energy Balance = -0.1380 GWh

### NON-RENEWABLE PRIMARY ENERGY BALANCE:

When Primary Energy Imported(+) :

|                     | Delivered energy |   | PEFnon |   | Non Primary Energy |
|---------------------|------------------|---|--------|---|--------------------|
| elect_grid national | 0.081            | ■ | 1.15   | = | 0.12               |

When Primary Energy Exported(-) :

|                 | Delivered energy |   | PEFnon |   | Non Primary Energy |
|-----------------|------------------|---|--------|---|--------------------|
| DH_national aw. | -0.249           | ■ | 1.03   | = | -0.26              |

PRIMARY ENERGY BALANCE (NON-RENEWABLE) = -0.138

PED Achieved!

Figure 38: non-RES Balance in MAKING-CITY tables for Groningen South in GWh/year

# Energy Flow Diagram: North PED

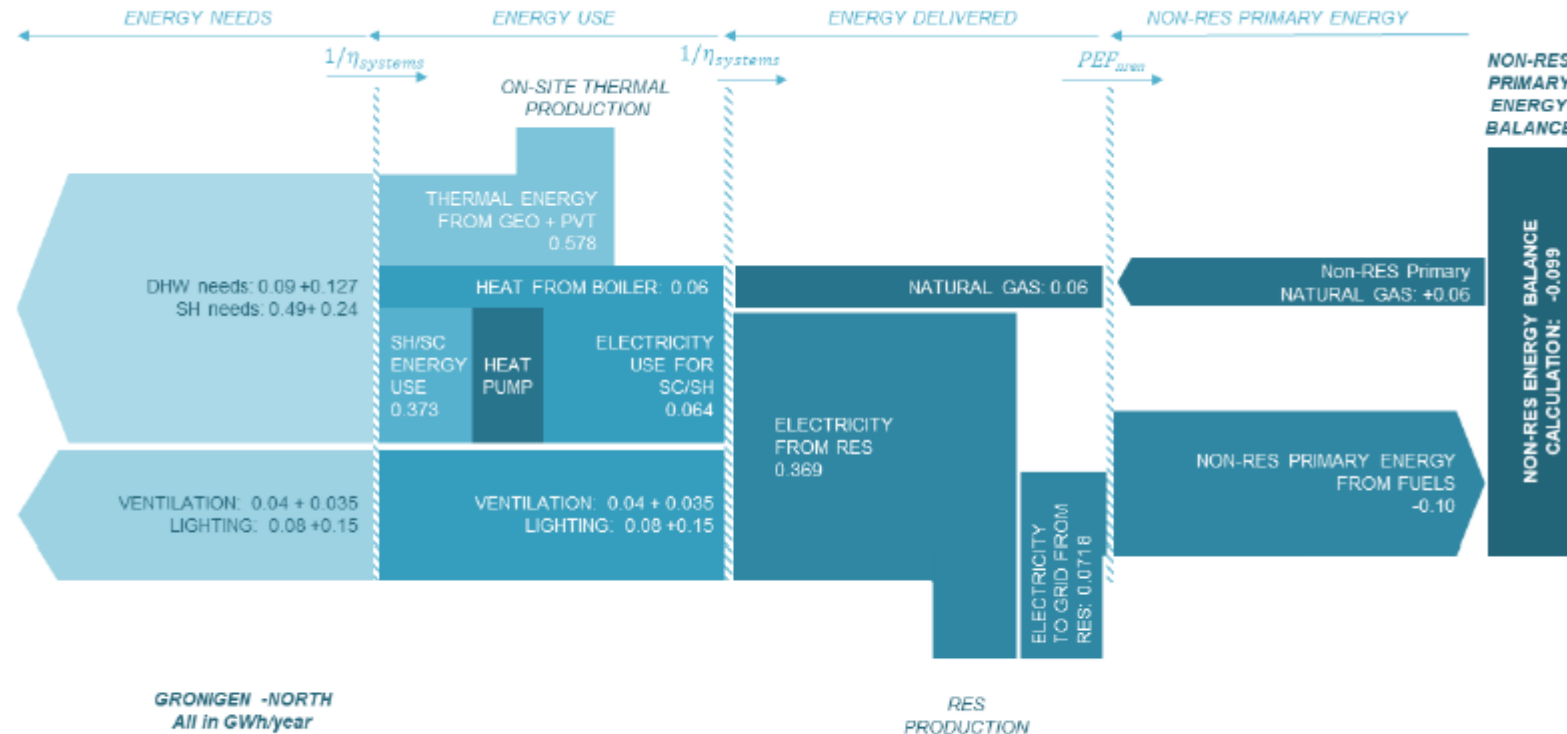


Figure 39: Energy flows (Sankey Diagram) in MAKING-CITY tables for Groningen North in GWh/year

# Energy Flow Diagram: South PED

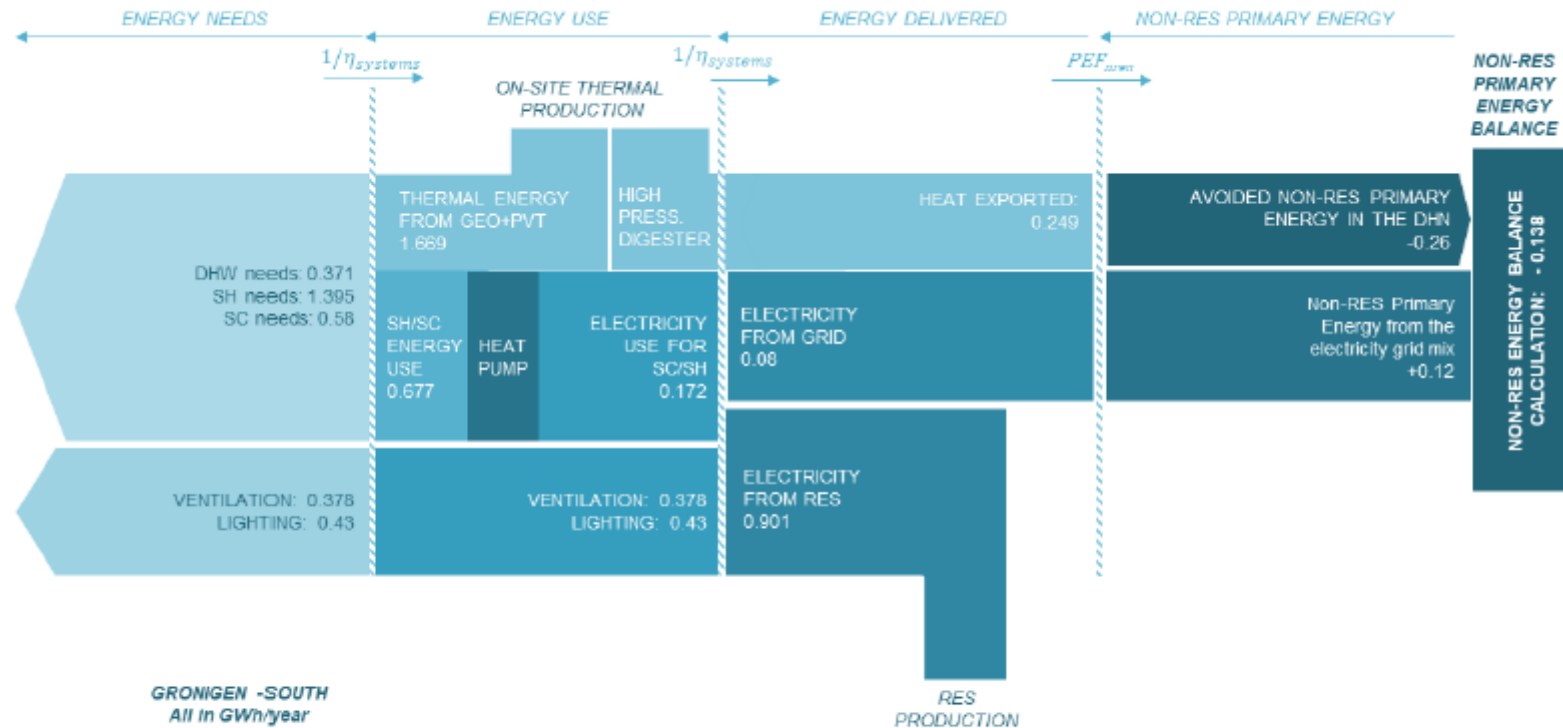


Figure 40: Energy flows (Sankey Diagram) in MAKING-CITY tables for Groningen South in GWh/year

# Reflection

- ▶ Business case for solutions/interventions not always determining; other arguments may also be prevalent

# Thank you

## Get in touch for more information!



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