Gemeente Amsterdam

Amsterdam Zuidoost:

86057	6233	422876	92057
Inwoners	Ondernemingen	Ton CO2 per jaar	Huishouden-equivalenten primair energiegebruik

Data heat in Amstel III and the challenges.

Feasibility study Amstel III

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25-10-2021

Transition towards a sustainable city of Amsterdam

- Ambitions
- Sources of heat
- Challenges
  - Harvesting heat for the city and its citizens
  - Minimising impact electricity infrastructure
  - Maximising energy efficiency of datacenters

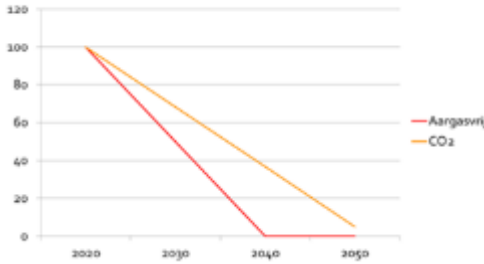
- Making it work
- What have we done so far ?
- And where are we now

- Your feedback: what lessons can we take back to Amsterdam?

NL-Laws and regulations

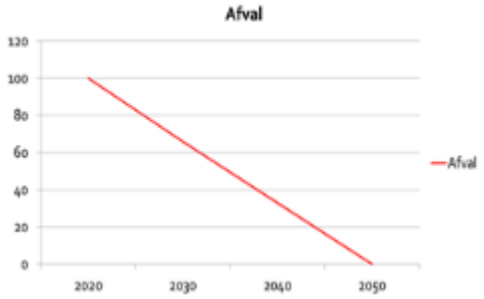
- VET Act (natural gas-free) - 1 July 2018
- Motion council, LT new construction - November 2017
- EPC 0.2 through crisis and recovery law 15 February 2019
- Vision BENG by Adam 1 jan 2021
- Building Decree: assessment of sustainability of residual heat sources -
  - Amsterdam Source book heat- January 1, 2020
  - Amsterdam Flex book electricity 1 June 2021
- BENG-NTA8800- January 1, 2021
- Heat Act 2.0 - January 1, 2022?
- Environment law – Juli, 2022? And BENG for A'dam?
- Fully circular National Goal 2050

Energietransitie

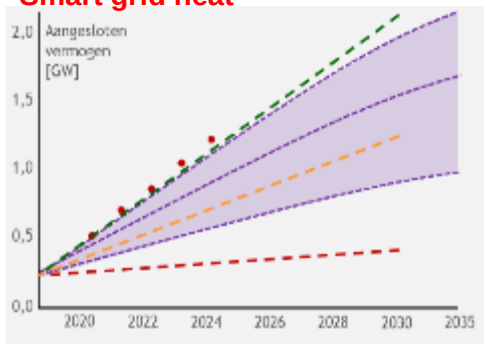


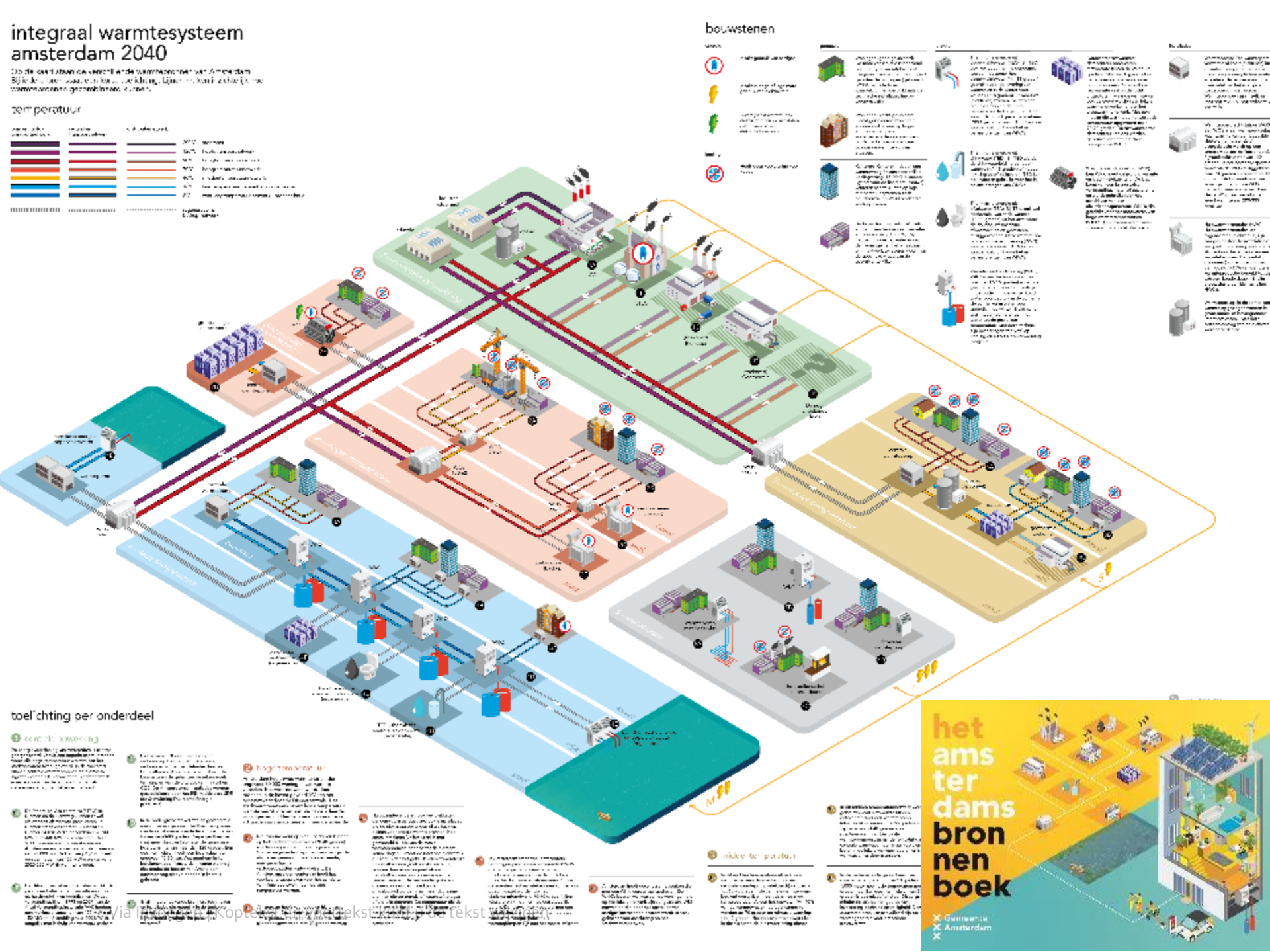
Klimaatverandering

Circulaire economie



Smart grid heat




integraal warmtesysteem
amsterdam 2040
temperatuur
bouwstenen
toelichting per onderdeel
het amsterdams bronnenboek
Gemeente Amsterdam

Smart city heating nets

Target

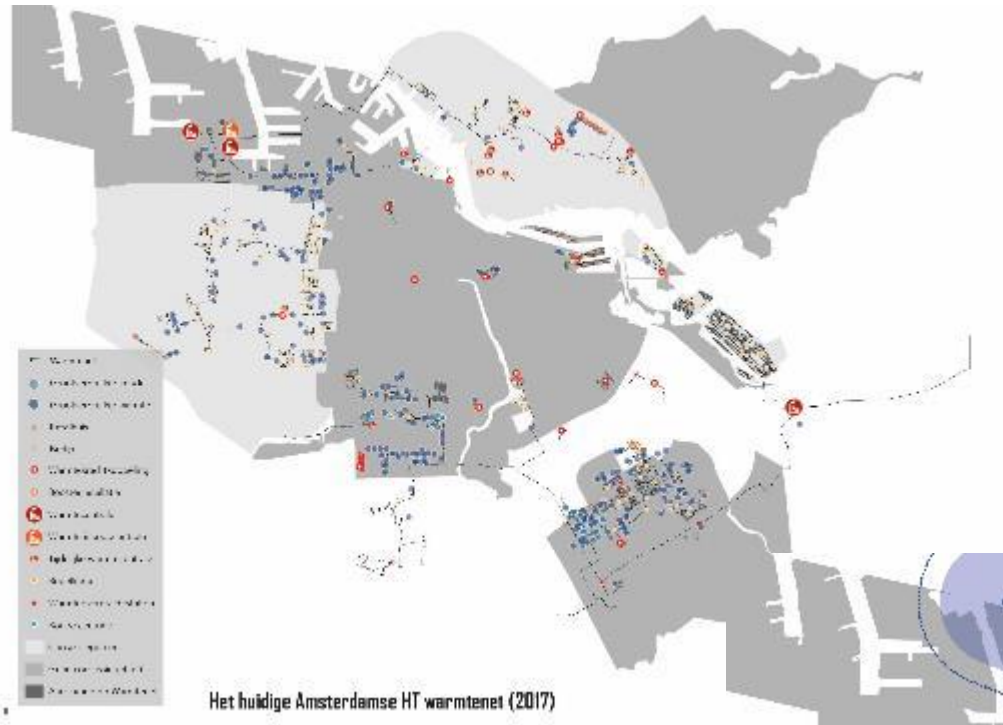
- Fossilfree heating & cooling for the entire city in 2040
  - 483.000 housing equivalents existing city
  - 125.000 housing equivalents development

Sources

- district heating (Vattenfall) – currently 90.000 housing equivalents
- aquathermal energy - under construction 5.000 housing equivalents
- utilisation heat datacenters – investigating pilots

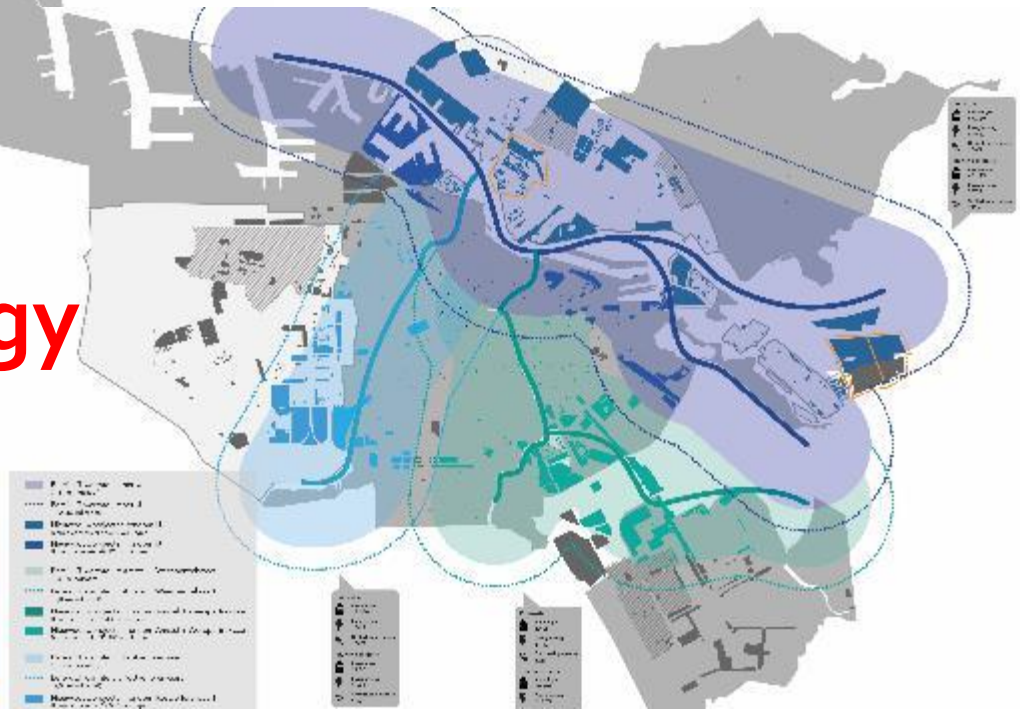
Existing heating district

(110-120 ˚C – retour 70 ˚C / local 70-40 ˚ C)

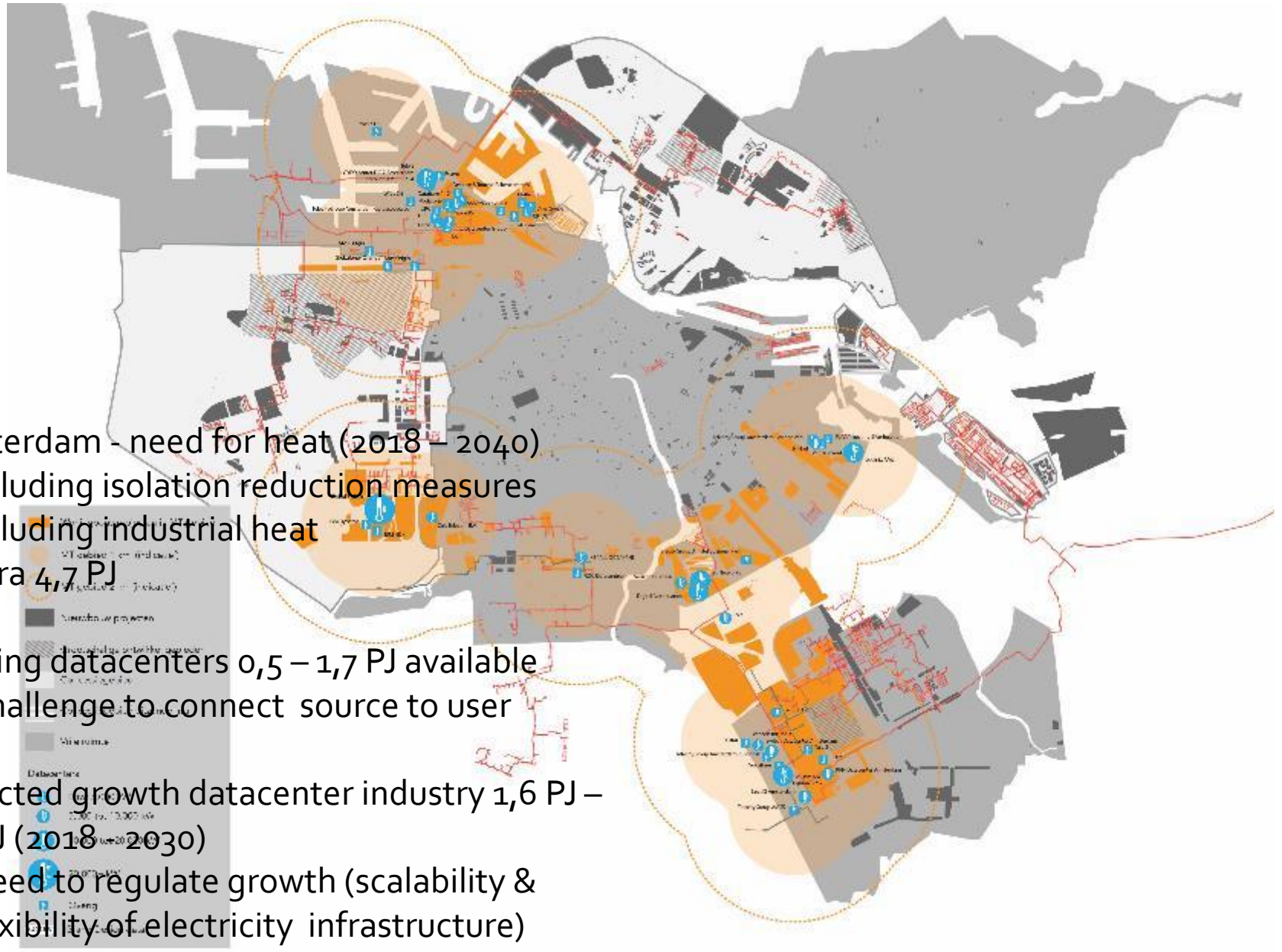


Aquathermal energy – surface water

(4 ˚ C – 25 ˚ C)



Datacenters (20 ˚ C – 35 ˚ C)



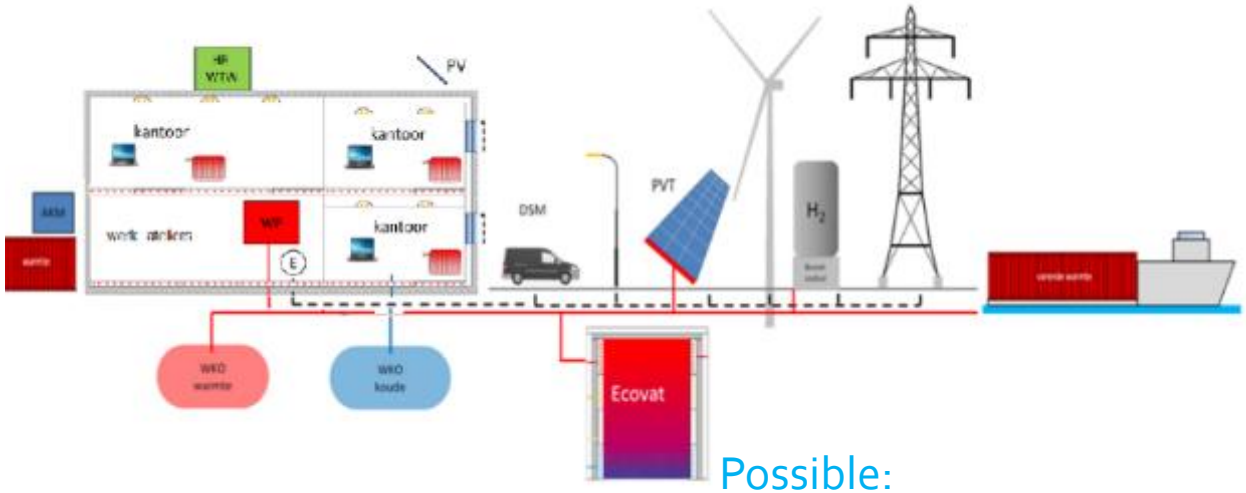
Amsterdam - need for heat (2018 – 2040)
* excluding isolation reduction measures
* excluding industrial heat
= extra 4,7 PJ

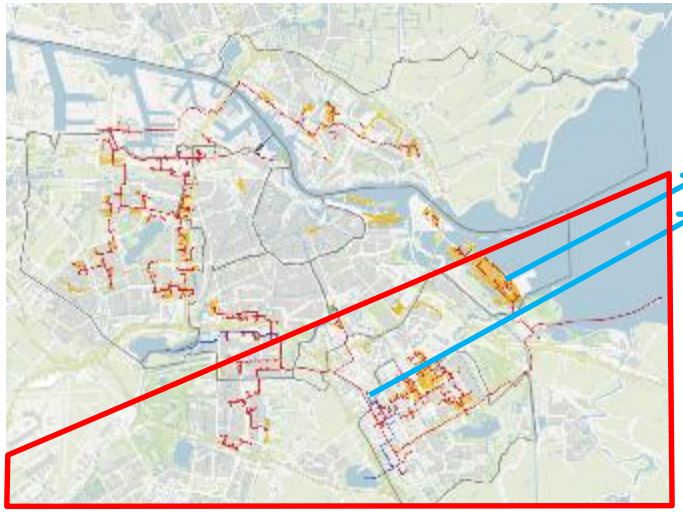
Existing datacenters 0,5 – 1,7 PJ available
> challenge to connect source to user

Expected growth datacenter industry 1,6 PJ – 7,9 PJ (2018 – 2030)
> need to regulate growth (scalability & flexibility of electricity infrastructure)

'Our heat is available for free'

(says: the Dutch Datacenter Association in 2017 to minister of Economic Affairs)



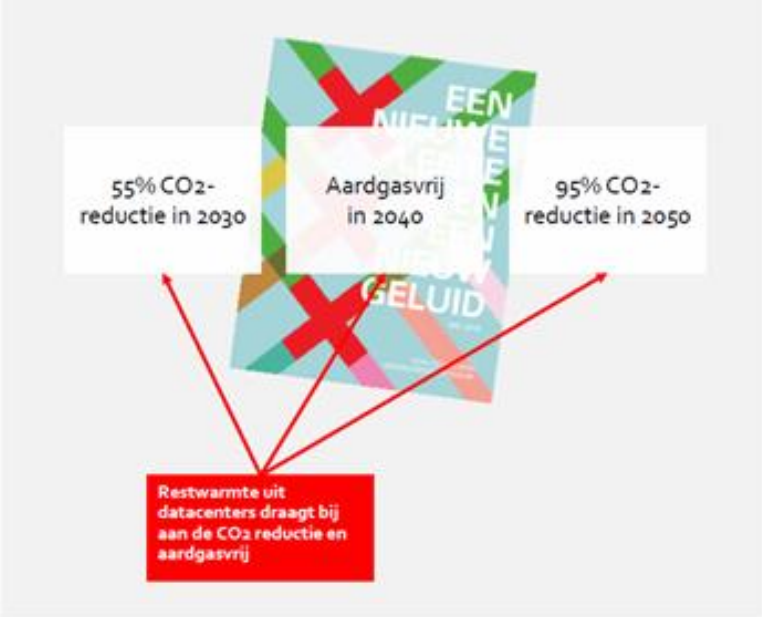


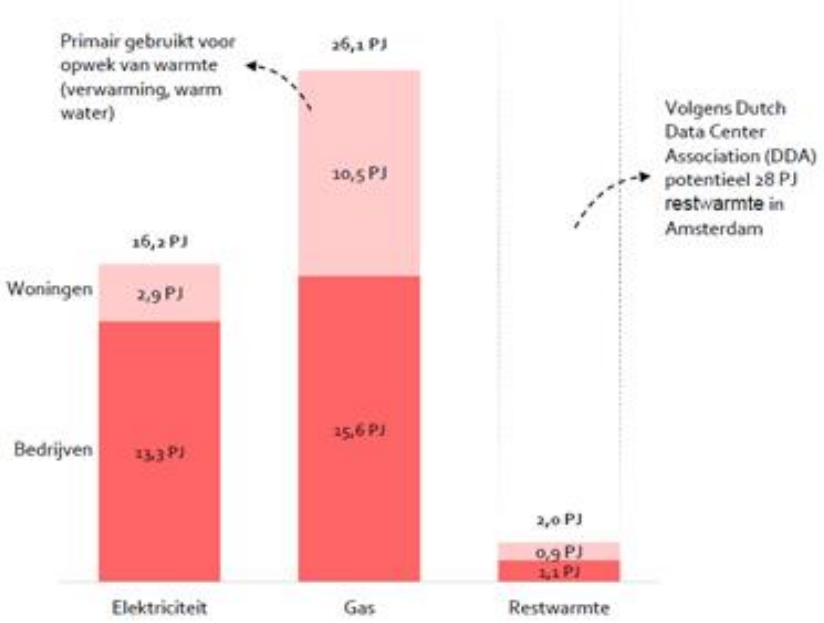
Possible:
50-100 %
CO_2
reduction
compared
to gas

50 % CO_2 reduction compared to gas

Reduction Co2

Heat plays an important goal in achieving climate goals - Total current energy demand built environment in Amsterdam





Bron: work in progress versie van City-zen Roadmap Amsterdam 2019, DDA Datacenters & Restwarmte 2018

Residual heat from data centers can play an important role in reducing CO2 emissions in the built environment. 410 kton reduction is possible. That is 12% of the task of the NL Climate Table for the Built Environment. Source rapport Berenschot and IF Technology.

For gas this is approx. 57 kg CO2/GJ and district heating 32 kg CO2 and data heat approx. 3 kg Co2 when powered with wind energy.

Gemeente
Amsterdam

Making it work in South-East

1. Connecting to heating district
2. Connecting to local ATES
3. Connecting to building / consumer
4. Amstel III in South East Amsterdam
5. Building codes

Sources Amstel III

- Existing heat and cold grid

Synergy with construction assignment and sewer and street replacements

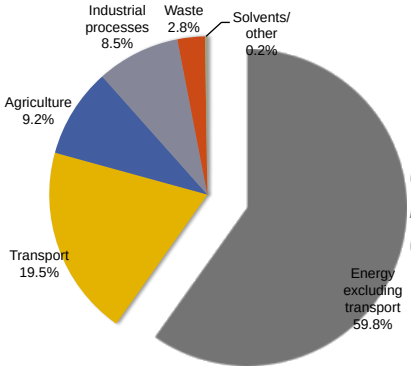
- Relatively more potential for peak reduction

» Data centers and ATES sources

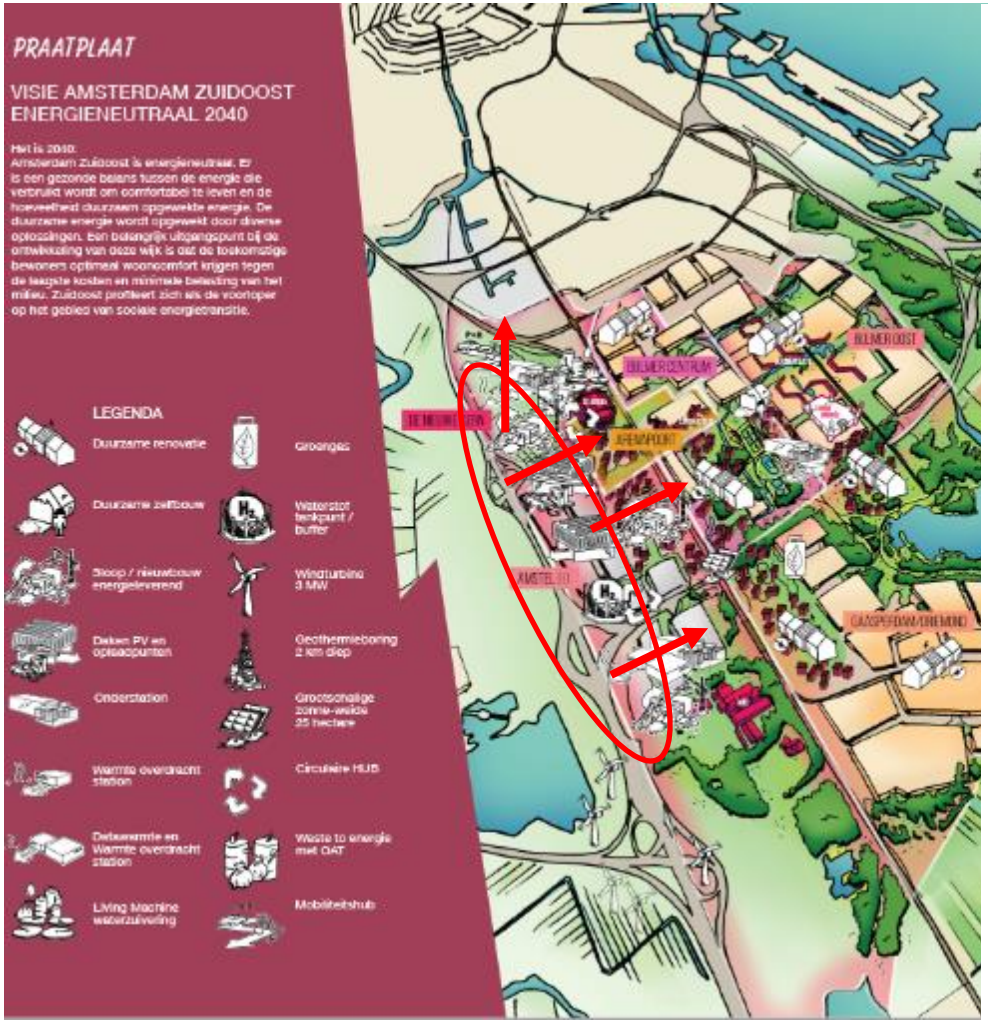
» Large peak reduction possible by integrating heat/cooling network

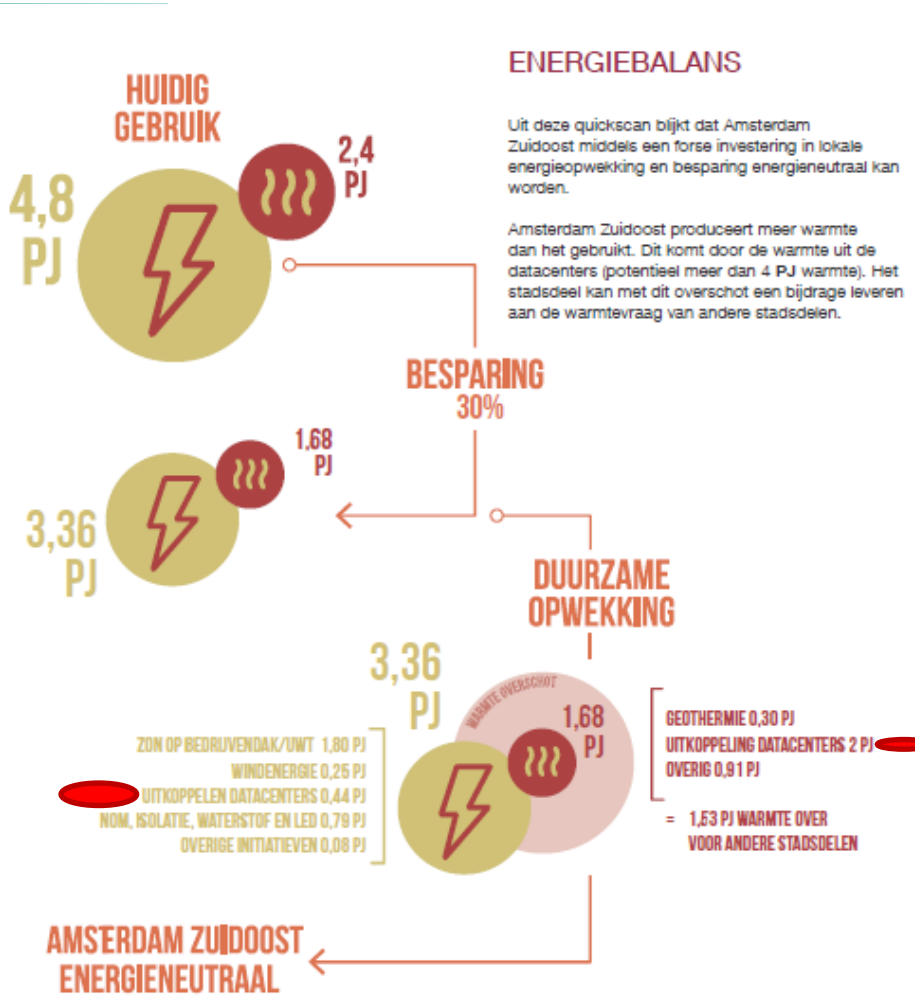
» Opportunities for battery storage, linking heat pumps, and EVs

South east Amsterdam Energy neutral through cooperation



Greenhouse gas emissions by sector, EU-27, 2007 (Eurostat)

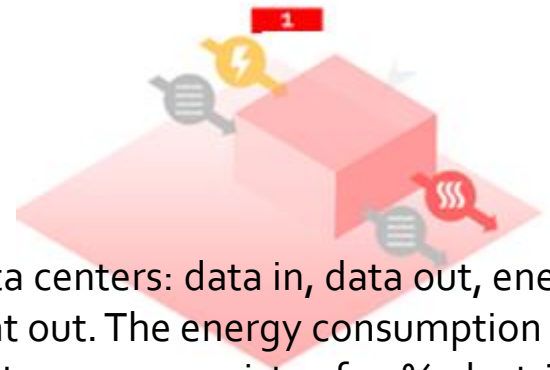




Energy savings in A'dam-SE

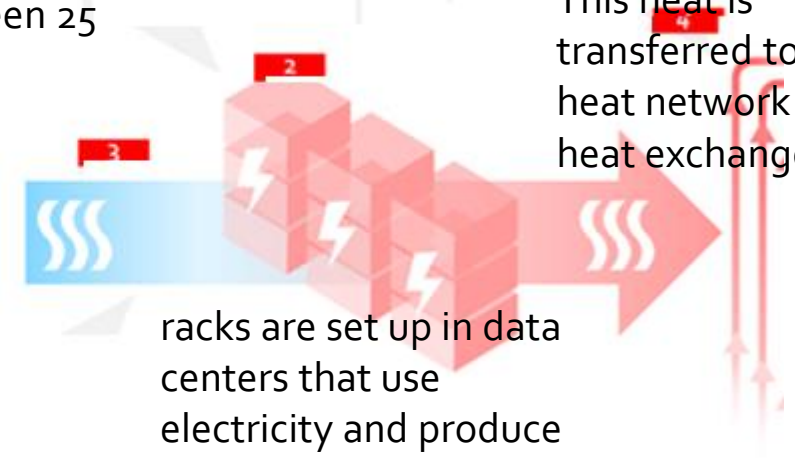
	Dataheat 4 DC's	BENG '21	GJ available	New data centers	BENG '19/21
	PJ total	PJ heat extr	houses	PJ max	houses
2020	0,65	0,39	19.500		
2025	1,2	0,9	45.000	1,3	65.000
2030	1,65	1,3	65.000	1,8	90.000
Total GJ	3,5	2,59		3,1	
Total new Houses	155.000		New build	47.000	

Approximately 1/3 heating and 2/3 tap water for BENG homes. Beng 2021: 50Kwh/m2 BENG norm times 100m2 and then turn it into GJs. You come on approx. 20. For smaller homes it will also be less but not mutch of 2/3 tapwater. 1 gigajoule corresponds to about 35 to 40 m3 of gas. As a result of dry heating, consumption can increase by 10 to 30 gigajoules in the first year.



Data centers: data in, data out, energy in, heat out. The energy consumption of data centers now consists of 99% electricity and is converted almost 1 to 1

circulation of cool air ensures that the temperature remains constant between 25 degrees and 35 degrees.



the warm air heats water in the pipes. This heat is transferred to the heat network by a heat exchanger

racks are set up in data centers that use electricity and produce heat 24 hours a day

Development Amstel III

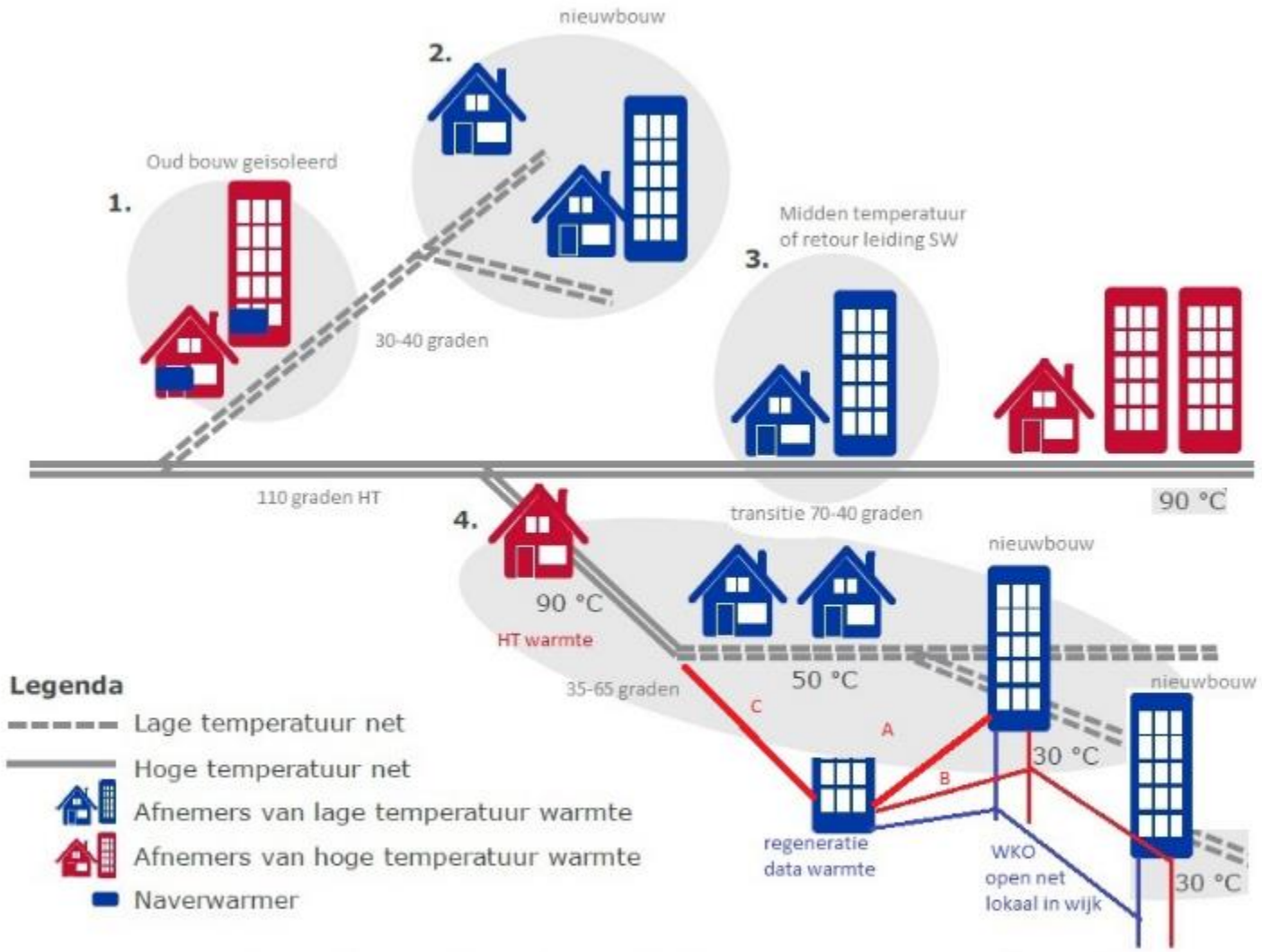
- 15.000 appartements
- 3.000 - 4.500 appartment (< 2023)
- 2 districts: 3821, Paasheuvelweg en Urban District
- 1604 parkeerspaces (15% EV)
- Commercieal (8.333 m2)
- Offices (47.266 m2)
- Shops and others (20.704m2)
- Datacenters: AM9 en AM10 (55 & 25 MW)

(Re) development of office buildings and facilities

Limited capacity on the electricity network

In this feasibility analysis it is assumed that the energy system of the existing office buildings will not be electrified before 2023 – feasibility flex study Amstel III Spectral/City Adam/Alliander)

Future heat network in mixed area



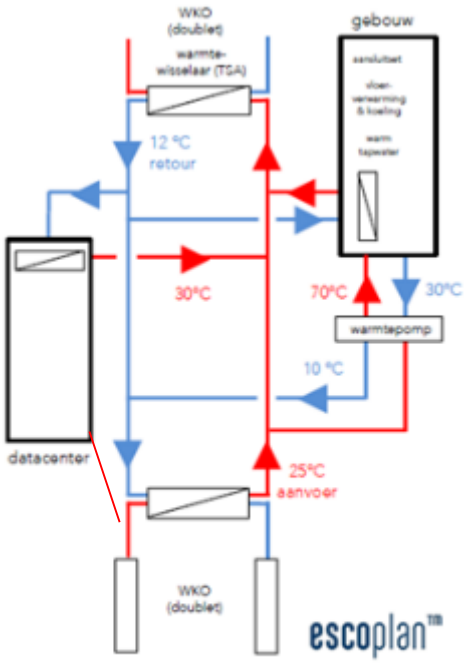
Figuur 3-1. Mogelijkheden om de transitie van bestaande HT-netten naar LT-netten in te vullen (1. naverwarmer, 2. gescheiden temperatuur zones, 3. aansluiting op HT-retourleiding en 4. cascadering

Open heat,- and coldnetwork

Datacenter
-currently, the residual heat in data centers is blown into the air by cooling machines. When connected to a cooling network, the data center receives a cold temperature of 12 degrees and supplies heat of approximately 30 degrees
-A heat exchanger (TSA) ensures that the data center circuit is separated from the distribution network
- The temperature who goes back to the datacenter approx -10 degree.

Distribution network
-In the area, a distribution network is provided with both cold via ATES (WKO) of 12 degrees and data heat of 25 degrees
-This can be connected to the data center, ATES systems and buildings
-A TSA heat exchanger ensures that the circuit of the ATES systems is separated from the distribution network

Buildings
- Buildings receive heat of approximately 25 degrees in winter and cold of 12 degrees in summer
for tap water it is delivered at 25 degrees and this saves 1 heating level in the heat pump

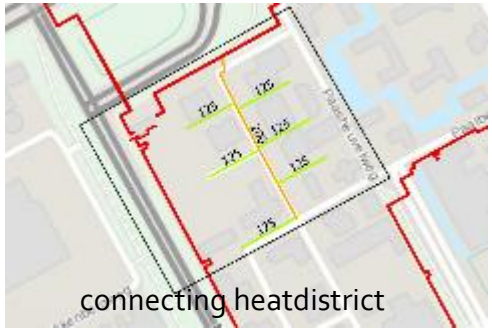


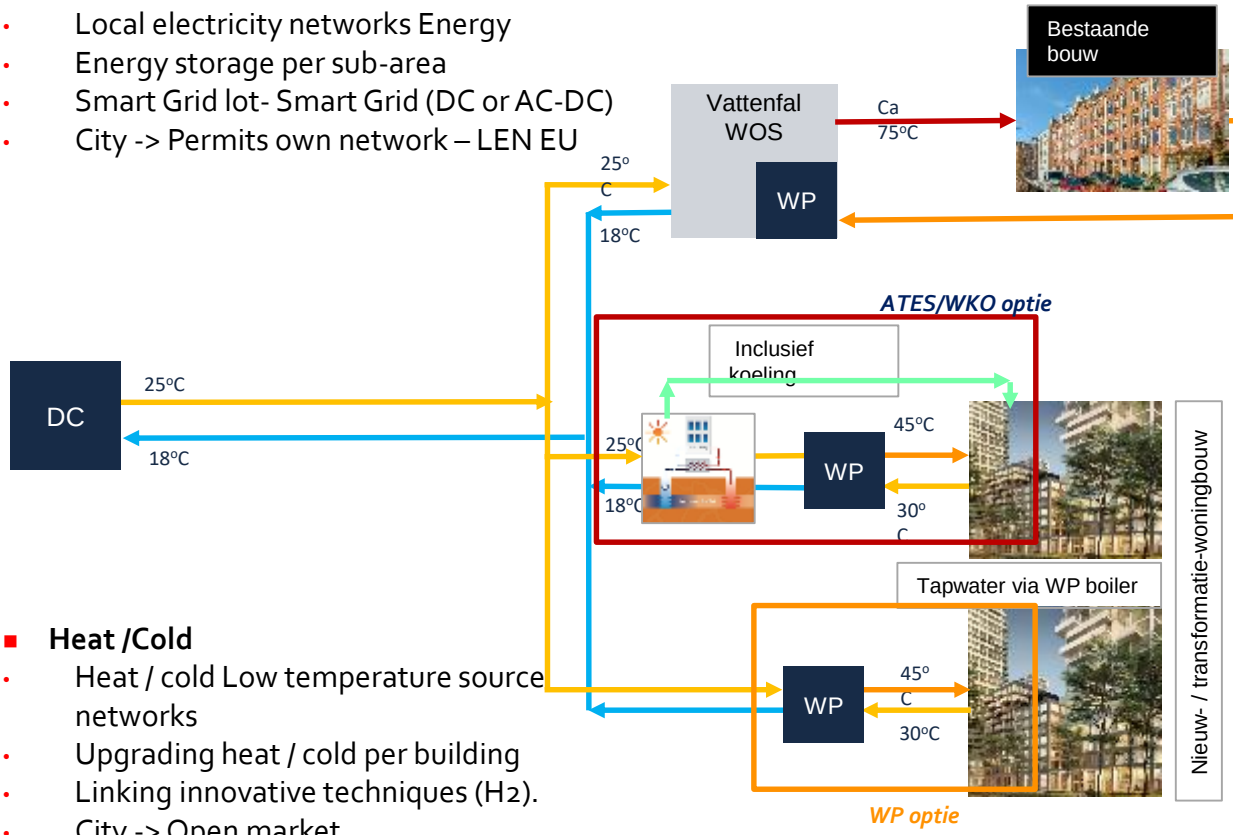
Bron: Duurzame Ring Heerhugowaard, januari 2019
Noot: geen ontwerp, slechts bedoeld ter illustratie

1.000-3.000 WEQ network

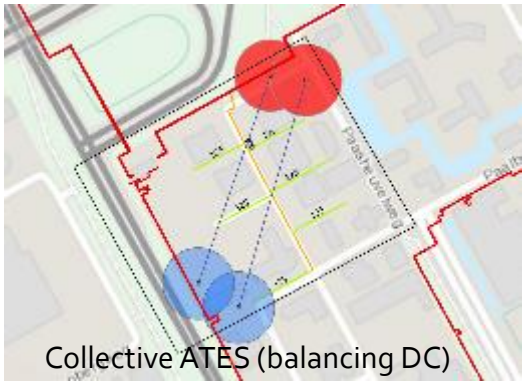
Area with a mix of excisting and new buildings

- **Elektra**
  - Local electricity networks Energy
  - Energy storage per sub-area
  - Smart Grid lot- Smart Grid (DC or AC-DC)
  - City -> Permits own network – LEN EU

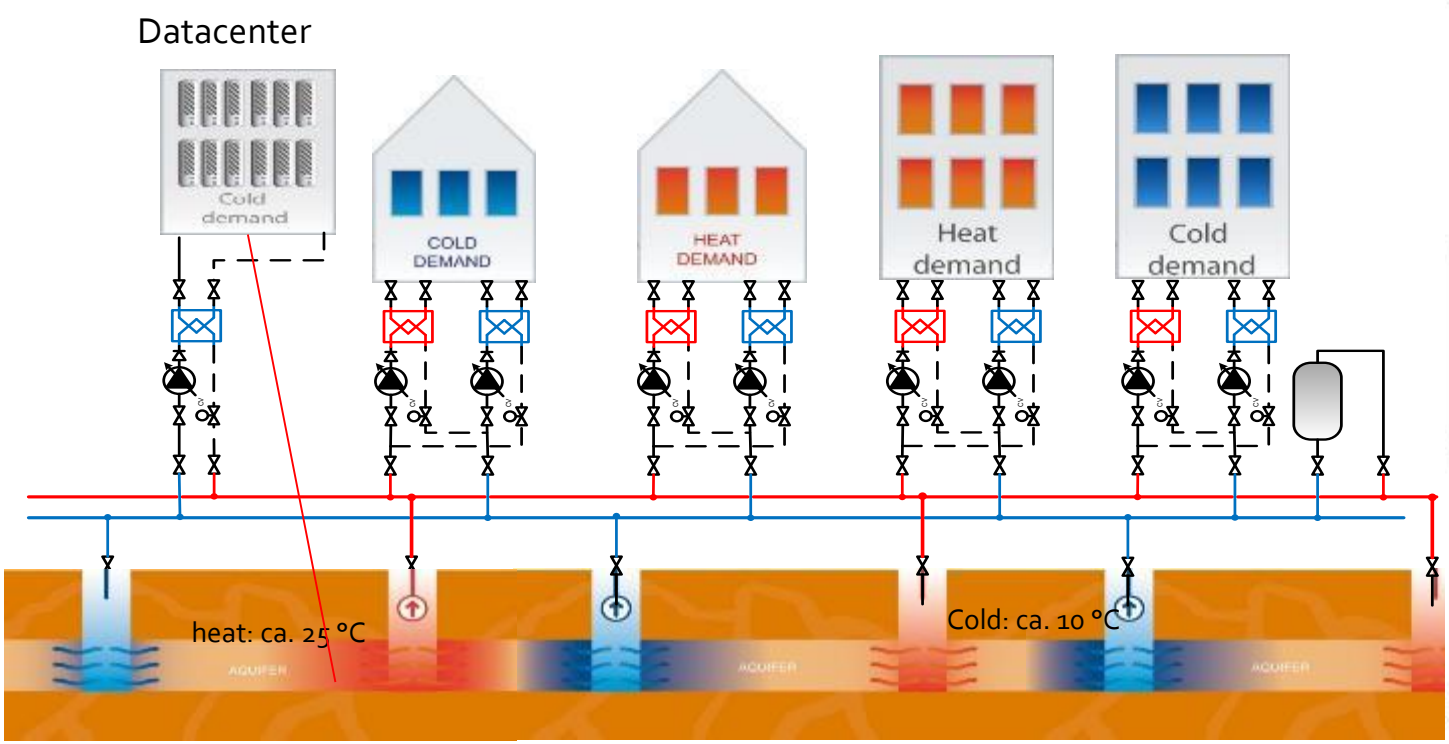




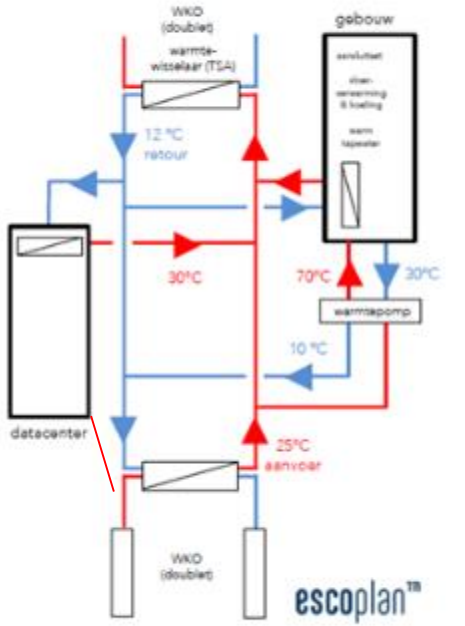
- **Heat /Cold**
  - Heat / cold Low temperature source networks
  - Upgrading heat / cold per building
  - Linking innovative techniques (H2).
  - City -> Open market
  - Cabels and pipes regulated
  - Good quality buildings (isolation and installation)
  - Data heat is possible Regeneration sources water,
  - Preferably no dry coolers



Aquifer Thermal Energy Storage (ATES)



Principe schema van een laag temperatuur distributienet met bronnen en restwarmte en -koude



Bron: Duurzame Ring Heerhugowaard, januari 2019
Noot: geen ontwerp, slechts bedoeld ter illustratie

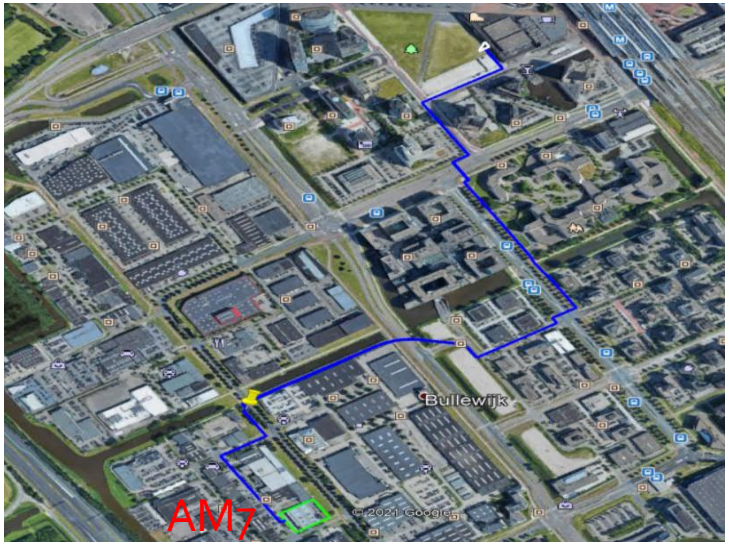
Official documents

ATES interference area ‘21

ATES plan ‘22

Heat plan 1 ‘23

Heat plan 2 ‘24

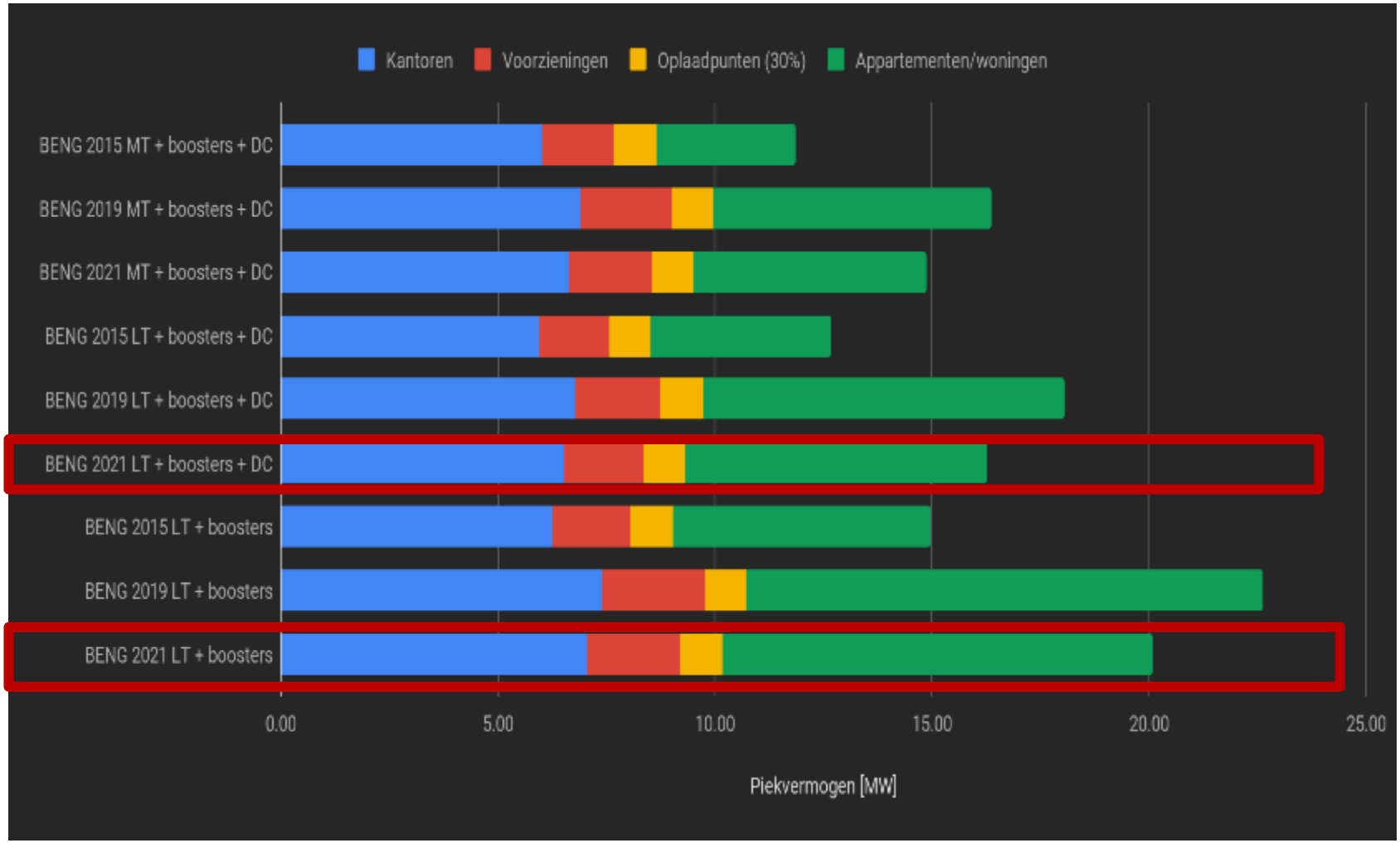


Impact different BENG-codes

- Peak power highly dependent on heat / cold demand for residential construction
- Large differences in peak between BENG standards for residential construction
- 2019/2021 about 2x as high peak as BENG 2015
- BENG 2021 about 60-70% higher peak than BENG 2015
- New BENG Amsterdam EPC 0,2-> houses 60-20-70 (BENG1,2,3)
- BENG standard is less significant for offices and facilities
- as a result of a much more dominant peak consumption by equipment and lighting
- Cold demand increasingly dominant (both peak and total) at lower BENG-1
- In the case of LT + booster WPs, the largest peaks are expected.
- Electric boilers will cause much larger peaks and can lead to problems

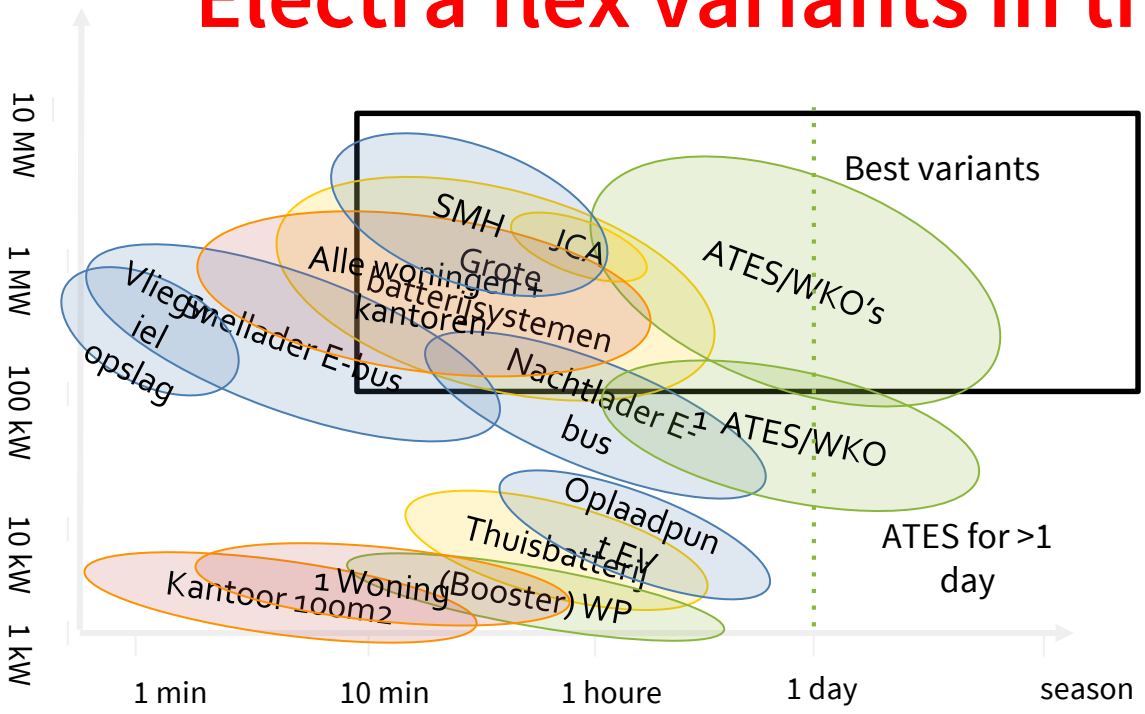
In this feasibility analysis it is assumed that the energy system of the existing office buildings will not be electrified before 2023 – feasibility flex study Amstel III Spectral/City Adam/Alliander)

Devellopments and governement rules

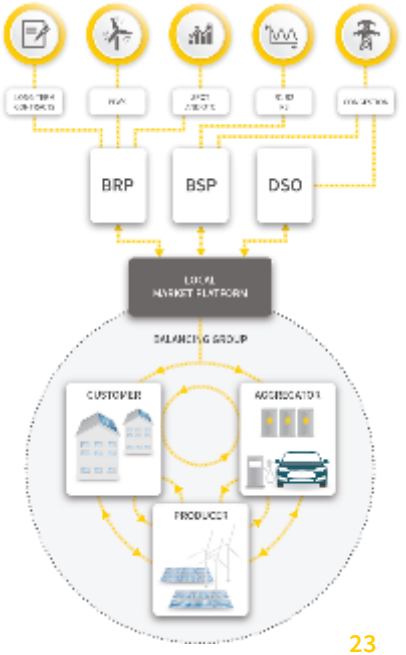


In this feasibility analysis it is assumed that the energy system of the existing office buildings will not be electrified before 2023 – feasibility flex study Amstel III Spectral/City Adam/Alliander)

Electra flex variants in this area



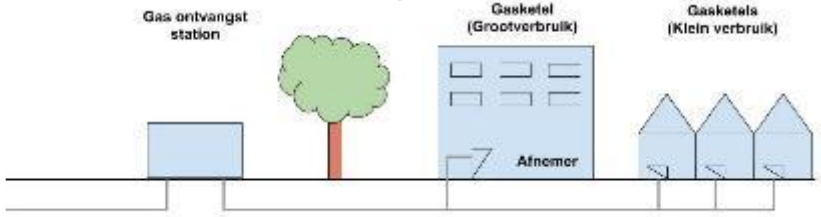
www.ams-institute.org/urban-challenges/urban-energy/local-inclusive-future-energy-life-city-platform/



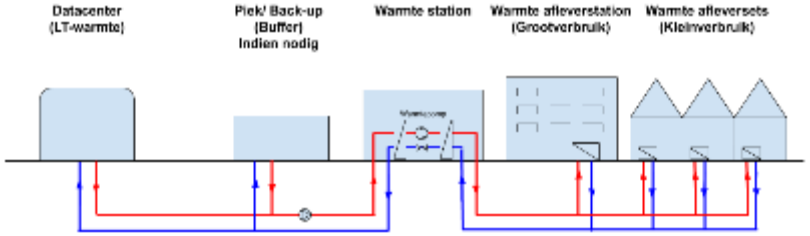
In this feasibility analysis it is assumed that the energy system of the existing office buildings will not be electrified before 2023 – feasibility flex study Amstel III Spectral/City Adam/Alliander)

Energy concepts from gas to the future

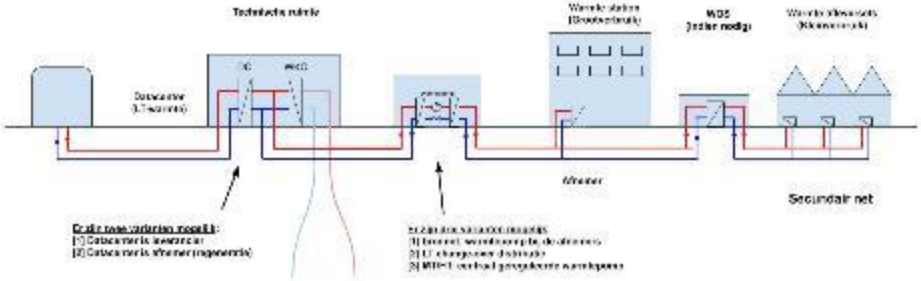
0: individual natural gas boiler -reference



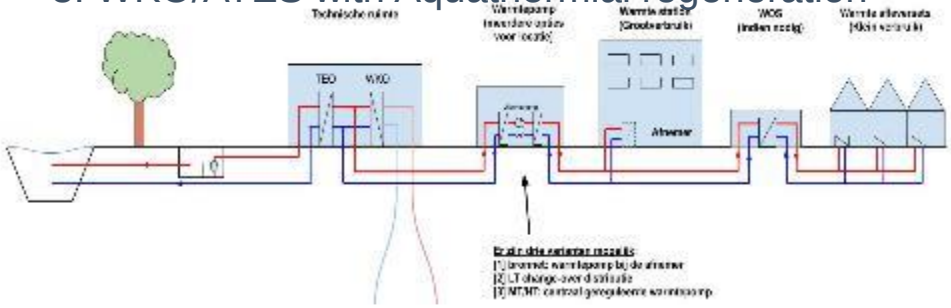
1: Datacenter with LT-buffer



2: WKO/ATES with Datacenter regeneration



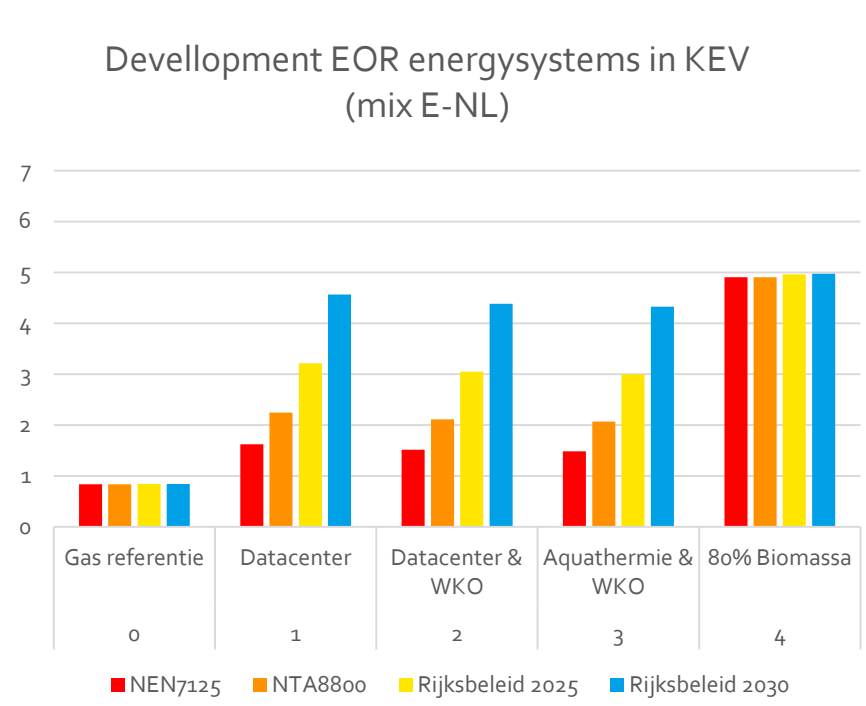
3: WKO/ATES with Aquathermial regeneration

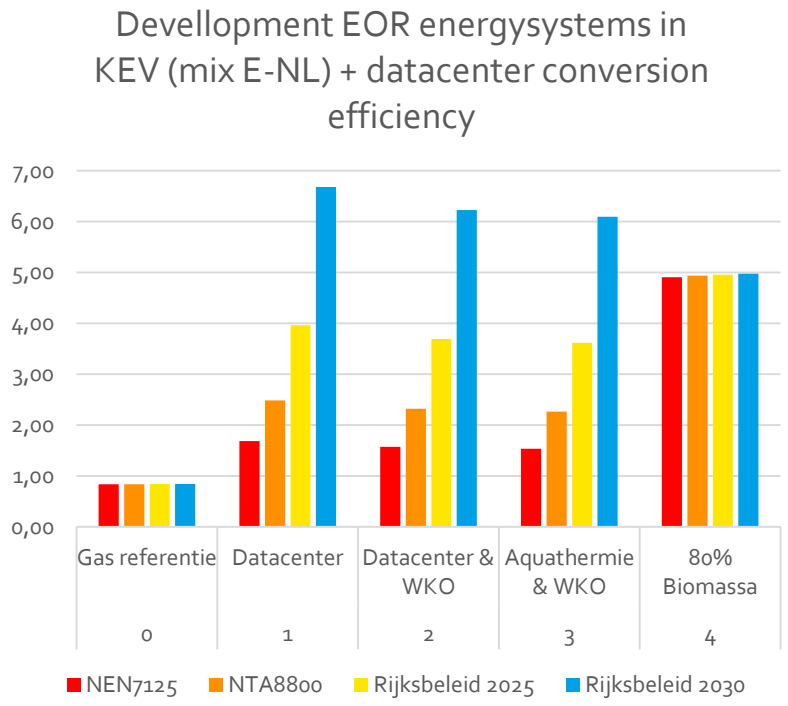


4: Optional fourth system Biomass +20% natural gas/Diemen heat
5: Geothermal with 20% KEV for WP

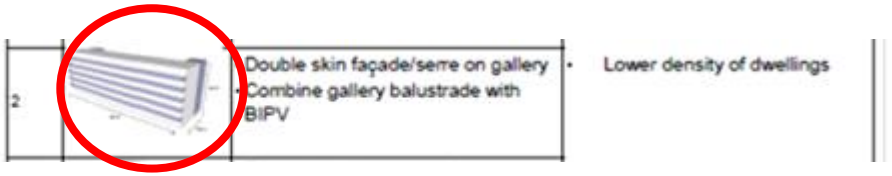
Sustainable index

- From 2021 the electricity mix in NL will be more sustainable because the nationale electricity mix will be with more PV en Wind etc (KEV).





2. 6 lagen woningen, corridor,



Results (Amsterdam buildingtype 2) Amstel III

BENG RIJK 2021

BENG A'dam 2022?

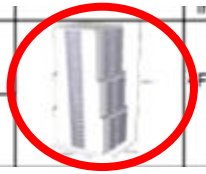
		Sc 1: Referentie (50% PV)	Sc 2: Referentie forfaitair (50% PV)	Sc3: Externe levering reguliere eis (50% PV)	Sc4: Externe levering reguliere eis (0% PV)	Sc5: Externe levering aangepaste eis (50% PV)	Sc6: Externe levering aangepaste eis (0% PV)
	Indicator	Individuele WTP	Individuele WTP	Externe warmtelevering	Externe warmtelevering	Externe warmtelevering	Externe warmtelevering
CV	Fpdel	nvt	nvt	0,75	0,55	0,3	0,15
	Fpren	nvt	nvt	0,3	0,5	0,5	0,65
Tap	Fpdel	nvt	nvt	0,85	0,7	0,44	0,22
	Fpren	nvt	nvt	0,2	0,4	0,4	0,6
BENG 1		51,56	51,56	51,65	51,65	49,26	49,26
BENG 2		15,08	28,24	48,59	49,83	19,86	19,71
BENG 3		79%	63%	47%	42%	71%	71%

Voldoet aan reguliere eis
Voldoet aan aangepaste eis

On average 1/3 space heating and 2/3 tap water for NZEB homes
Goal: to be at least 5% better than 40% BENG 3 – grow to BENG 3- 70%

4. Toren van 70 meter

5. Toren van 100 meter

4		Facade area for PV integration	•High space need for installation •Less area for BIPV •Difficulties for airtightness and natural ventilation due to high wind speeds
5			

Results (Amsterdam buildingtype 4/5) Amstel III

BENG RIJK 2021 BENG A'dam 2022?

		Sc 1: Referentie (1.962 m2 PV)	Sc 2: Externe levering reguliere eis (1.962 m2 PV)	Sc 3: Externe levering reguliere eis (geen PV)	Sc 4: Externe levering aangepaste eis (1.962 m2 PV)	Sc 5: Externe levering aangepaste eis (geen PV)
	Indicator	Individuele WTP	Externe warmtelevering	Externe warmtelevering	Externe warmtelevering	Externe warmtelevering
CV	Fpdel	*nvt*	0,9	0,8	0,65	0,2
	Fpren	*nvt*	0	0,4	0,5	0,95
Tap	Fpdel	0,59	0,9	0,85	0,7	0,3
	Fpren	0,15	0	0,35	0,45	0,9
BENG 1		58,32	58,32	58,32	49,88	49,88
BENG 2		11,51	33,79	49,45	19,46	19,54
BENG 3		83%	51%	40%	70%	70%

Voldoet aan reguliere eis

Voldoet aan aangepaste eis

On average 1/3 space heating and 2/3 tap water for NZEB homes

Goal: to be at least 5% better than 40% BENG 3 – grow to BENG 3- 70%

Issues too study

1. Technical - financial

- Technology heating pumps
- Businesscase 3-4-5th gen.

2. Governance

- Contracts & collaboration
- Co-use electricity
- infrastructure DC (Tennet/Alliander)
- ATES and dataheat combination

3. Regulatory framework

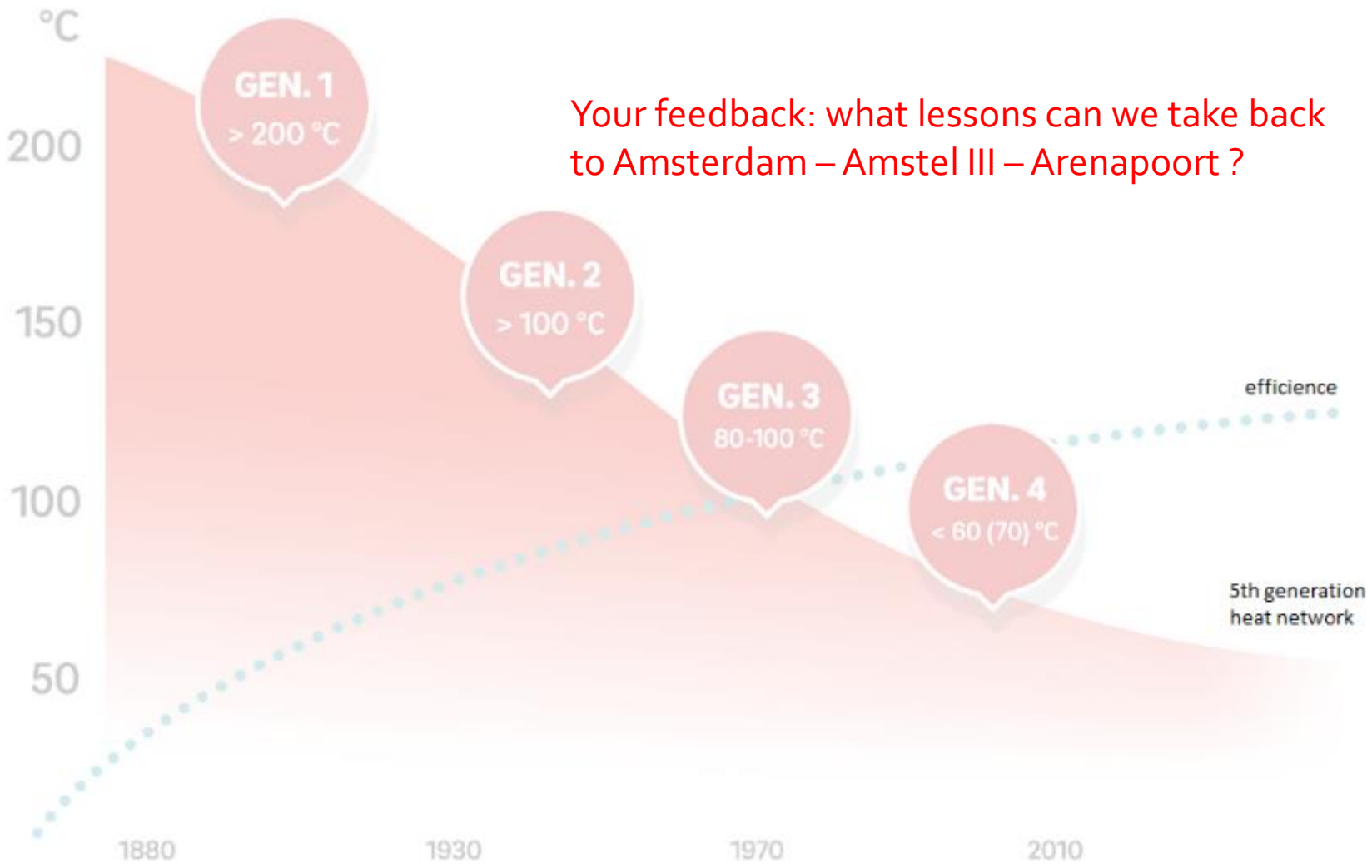
- Calculation EOR (SPF)
- Role government NL and City
- European framework
- Cooperation datacenter-sector
- Heat category NTA8800 datacenter

Assumptions Amstel III:

- Heat network 3-4-5th generation (Amstel III)
-basic system 10.000m2 building: WKO Beng '21 or more (with MT network to connect, current status 2019, municipality: 30°C (LT) and (70= MT)
-LT network + booster heat pumps: + 30% peak*
-Data center residual heat: - 30% peak
incl. WP air / water: + 50% peak (not included)
-Power factor: 0.85-0.9 MW / MVA (Liander)
-3821 apartments
-Hot tap water preparation not simultaneously with space heating

In this feasibility analysis it is assumed that the energy system of the existing office buildings will not be electrified before 2023 – feasibility flex study Amstel III Spectral/City Adam/Alliander)

Questions ?



Your feedback: what lessons can we take back to Amsterdam – Amstel III – Arenapoort ?

Gemeente Amsterdam

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SPOT 120 m

	Waarde	Toelichting
BENG 1 (kWh/m2/jr)	52	Toepassing triple glas Rc 4,5 - 4,5 - 6 qv = 0,25
BENG 2 (kWh/m2/jr)	7	WKO Balansventilatie Douche WtW
BENG 3 (%)	81	WKO, stadswarmte, PV

Karspeldreef 14-16 115 m

	Waarde	Toelichting
BENG 1 (kWh/m2/jr)	47	Toepassing triple glas Rc 4,5 - 4,5 - 6 qv = 0,25
BENG 2 (kWh/m2/jr)	17	WKO Balansventilatie (Douche WtW of warmte delen met de buren)
BENG 3 (%)	71	WKO+ PV Data regeneratie (later)