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Resource Efficient Cities Implementing Advanced Smart City Solutions – READY



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Disser	Dissemination level				
PU	Public	х			
РР	Restricted to other programme participants (including the Commission Services)				
RE	Restricted to a group specified by the consortium (including the Commission Services)				
со	Confidential, only for members of the consortium (including the Commission Services)				



### DELIVERABLE D.7.3



### Scope of deliverable

This deliverable summarizes the activities and the results of the monitoring of the installations and buildings in Aarhus/Denmark and Växjö/Sweden within READY.

Monthly monitoring data have been collected and analysed for all READY Demonstration Projects (RDP) regarding the energy consumption, production and the environmental and financial impact.

### **Context of deliverable**

The report is based on the READY demonstration activities in Aarhus and Växjö.

### Perspective of deliverable

The perspective of the deliverable is to present the monitoring results and disseminate the activities and solutions to achieve a higher degree of energy from Renewable Energy Sources (RES) in the energy utilization in cities, especially the building sector.

### **Involved partners**

AIT, COWI, ESS-SE, VEAB-SE, HOUSE-DK, MUN-DK et al.

### **Executive summary**

This deliverable describes the monitoring results for the READY Demonstration Sites in Aarhus in Denmark and Växjö in Sweden. The monitoring includes the measurement of energy consumption in the buildings and the energy production from Renewable Energy Sources (RES) at the READY Demonstration Sites (RDS) in order to assess the energy demand resp. production, in a normalised year. Further READY Demonstration Projects (RDP) regarding district heating/cooling and electric mobility were monitored as well.

The buildings were refurbished by means of Building Envelope Improvement (BEI) including new windows. These passive means are a requirement for achieving low energy consumption. The buildings are further equipped with active elements in the form of efficient balanced ventilation with a high degree of heat recovery, Photovoltaic (PV) and Photovoltaic Thermal (PVT) systems on roofs as well as Waste Water Heat Recovery (WW-HR) facilities and a Battery Energy Storage System (BESS) for self-consumption optimisation of the PV yield. The measures regarding district heating were performed by lowering the system's temperatures with the aim of reducing pipe heat losses and by installing a 1 MW sea water-fed heat pump increasing the share of renewable heat in the district heating network (Aarhus).

Further READY Demonstration Projects are the innovative district cooling project "energy used three times" (Växjö) and the installation of charging stations for electric vehicles (Aarhus).

In READY, the normalised average Final Energy consumption of all buildings is 64 kWh/m<sup>2</sup>yr, which meets the corresponding target value according to Building Energy Specification Table (BEST, see DOW) very well. Due to deviations from original planning regarding the installation of RES facilities (PV(T) systems, etc.), the monitored on-site RE production (at the sites of the refurbished buildings) of 5.9 kWh/m<sup>2</sup>yr does not in itself meet the corresponding target value. Nevertheless, this shortcoming is (over)compensated by the contribution of the above mentioned 1 MW sea water-fed heat pump in Aarhus harbour. This large heat pump can contribute with up to 6 GWh renewable heat to the district heating system per year.

READY's total environmental impact is a reduction of greenhouse gas (GHG) emissions of approx. 70 thousand tons  $CO_{2,eq}$  within a 30 years timeframe. As READY's 30 years GHG emission saving target was 57 Thousand tons, the corresponding achieved GHG emission savings of 62 Thousand tons (excluding the contribution of further measures), speaks for READY's success. The project and the results can be used as model for other construction projects. Furthermore, the results are disseminated and discussed in various fora.

### Acknowledgment

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JULY 2020

READY - RESOURCE EFFICIENT CITIES IMPLEMENTING ADVANCED SMART CITY SOLUTIONS

# D.7.3 Evaluation of the operational monitoring data of the demonstration projects

REPORT



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# List of Abbreviations

an.	Annual
AC	Alternating current
AIT	AIT Austrian Institute of Technology
Approx.	Approximately
AW HP	Air/water heat pump
BEI	Building Envelope Improvement
BESS	Battery Energy Storage System
BOPS	Electricity consumption for building operation
CA-SE	CA-Fastigheter AB
CA-SE2	CA I Växjö AB
	Combined Heat and Power
CHP	Carbon dioxide
CO <sub>2</sub>	
CO <sub>2,eq</sub>	CO <sub>2</sub> equivalent (emissions)
COP	Coefficient of performance
COWI	COWI A/S
D.	Deliverable
DANF-DK	Danfoss
DC	District Cooling
DC	Direct Current
DDHA	Danish District Heating Association, Grøn Energi
DH	District Heating
DHC-LT	Kauno Energija AB
DHW	Domestic Hot water
DK	Denmark
DK1	Code of the READY Demonstration Site in Aarhus with reference number 1
DK2	Code of the READY Demonstration Site in Aarhus with reference number 2
DK3	Code of the READY Demonstration Site in Aarhus with reference number 3
DK4	Code of the READY Demonstration Site in Aarhus with reference
	number 4
DK-Ch	Code of the READY Demonstration Project in Aarhus regarding the Charging Stations for Electric Vehicles
DKK	Danish Kroner
DK-PVT	Code of the READY Demonstration Project in Aarhus regarding a
	Photovoltaic Thermal System
DK-ST	Code of the READY Demonstration Project in Aarhus regarding a
	Battery Energy Storage System
DK-WW	Code of the READY Demonstration Project in Aarhus regarding a
	Waste Water Heat Recovery (WW-HR) System
DNU	The New University Hospital (Aarhus)
DONG-DK	DONG Energy
DOW	Description of Work
DTI	Danish Technological Institute

e.	Energy
EC	European Commission
EE	Energy Efficiency
electr.	electricity/electric
EMZI	Emanuele Zilio
EON-DK	E.ON Denmark
ESS-SE	
EUR	Energy Agency for Southeast Sweden Euro
EV	Electric Vehicle
EV FP7	
	Seventh Framework Programme (EU)
GWh	Gigawatt hours
h h-1	hour
h <sup>-1</sup>	per hour
HOUSE-DK	
HP	Heat Pump
	IKEA – Industry
KAM-DK	KAMSTRUP
kEUR	Thousand EURO
kWh	Kilo Watt hours
kWp	Kilo Watt peak
LB-DK	Lithium Balance
LEI-LT	Lietuvos Energetikos Institutas
LGI	LGI Consulting
LIBs	Lithium-ion Batteries
m²	Square metre(s)
MEUR	Million EURO
MUN-DK	Aarhus Municipality / AffaldVarmeAarhus
MUN-SE	Växjö Municipality
MW	MegaWatt
MWh	MegaWatt hours
N/A	Not Applicable
no.	Number
O&M	Operating and Maintenance (costs)
POC	Point of Connection
PV	Photovoltaic (system)
PVT	Photovoltaic Thermal (system)
q50	Design air permeability at 50 pascals pressure in $h^{-1}$
RDP	Ready Demonstration Project
RDS	Ready Demonstration Site
R&D	Research & Development
RAC-DK	RAcell- SME – Industry (original partner from proposal)
RE	Renewable Energy
READY	Resource Efficient Cities Implementing Advanced Smart City
	Solutions
ren	Renewable
RES	Renewable Energy Sources

resp.	Respectively
RMH	Reto Michael Hummelshøj
SBEH	Smart Building Energy Hub
SCF	Self-consumption fraction
SCIS	Smart Cities Information System
SCOP	Seasonal coefficient of performance
SE	Sweden
SE1	Code of the READY Demonstration Site in Växjö with reference
	number 1
SE1.1	Code of the READY Demonstration Site in Växjö with reference
	number 1.1
SE3	Code of the READY Demonstration Site in Vaxjo with reference
	number 3
SE-DH	Code of the READY Demonstration Project in Växjö regarding
	the District Heating Network in Alabastern
SEK	Swedish Kroner
SE-PVT	Code of the READY Demonstration Project in Växjö with a
	Photovoltaic Thermal System
SE-WW1	Code of the READY Demonstration Project in Växjö "Energy
	used three times" (district cooling project)
SE-WW2	Code of the READY Demonstration Project in Växjö with a Waste
	Water Heat Recovery (WW-HR) System
SPETS	Peak consumption supplied with primary district heating
	(Swedish term)
SPF	Seasonal Performance Factor
ST	Solar Thermal (system)
TN	Thomas Natiesta
UNI-DK	Aarhus University
UNI-SE	Linnaeus University
U-value	Thermal transmittance
VEAB-SE	Växjö Energy
VENT	Balanced domestic/office ventilation with efficient heat recovery
VFAB-SE	VÖFAB
VS	Versus
VXH-SE	Växjobostäder
WP	Work Package
WW-HR	Waste Water Heat Recovery (system/facility)
yr	Year(s)

# 1 Summary

This report, *D.7.3 Evaluation of the operational monitoring data of the demonstration projects* is a deliverable of the EU-funded project called READY. It contains monitoring data and analyses of the demonstration activities conducted in Aarhus/Denmark and Växjö/Sweden.

The monitoring data covers energy consumption of refurbished buildings, heat losses of energetically optimised district heating networks, the heat production and electricity consumption of heat pumps, the electricity (and heat) production of photovoltaic (thermal) systems and others. Some buildings and facilities were commissioned after 2018. Therefore, reliable monitoring data of a full calendar year (i.e. 2019) were not available for all buildings and facilities. Eventually, missing, implausible or non-representative measurement data were replaced by reliable data from other months and further input values (e.g. heating degree days).

Based on this data, comprehensive analyses concerning the environmental and economic impact of the undertaken measures was performed. In this report, the aggregated monitoring results and the outcome of the analyses are presented. Where applicable, the results from the monitoring data were compared with the energy consumption and production values stated in the Building Energy Specification Table (BEST) which is part of the Description of Work (DOW) of the READY project. This report proves that the BEST Targets are met and therefore, the READY project has been successful.

Energy consumption In 2019 resp. 2020, the monitoring data<sup>1</sup> from the READY Demonstration Sites (RDS)<sup>2</sup> in Växjö resulted in a Final Energy consumption<sup>3</sup> of 72 kWh/m<sup>2</sup>, which is 10 kWh/m<sup>2</sup> below the BEST Target Value of 82 kWh/m<sup>2</sup>.

In 2019 respectively 2020, the monitored Final Energy consumption of the buildings at the RDS in Aarhus was 59 kWh/m<sup>2</sup>per year which is even 13 kWh/m<sup>2</sup> below the BEST Target Value of 72 kWh/m<sup>2</sup>.

In **READY**, the average Final Energy consumption at all Demonstration Sites of the whole project was 64 kWh/m<sup>2</sup>yr, which is 12 kWh/m<sup>2</sup> below than the BEST Target Value of 76 kWh/m<sup>2</sup>.

<sup>&</sup>lt;sup>1</sup> In this report, unless otherwise noted, area-based values, representing a group of buildings, are floor area-weighted average values. When applicable, energy consumption/production values were normalised to reference conditions (e.g. heating degree days of a reference year see 3.3). For the definition of floor area see 3.2.1.

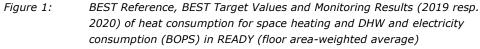
<sup>&</sup>lt;sup>2</sup> In this report, READY Demonstration Projects regarding building refurbishment are hereafter referred to as READY Demonstration Sites.

<sup>&</sup>lt;sup>3</sup> Heat consumption from district heating network for space heating and domestic hot water (DHW) preparation and electricity consumption for building operation (BOPS, lighting in common areas and centralized ventilation systems).

Hence, the monitoring data proves that the reduction in Final Energy consumption as targeted by the READY project is met.

Figure 1 shows the BEST Reference, the BEST Target Values and the Monitoring Results of the heat consumption for space heating and Domestic Hot Water (DHW) as well as the electricity consumption for building operation (BOPS) of the multi-family and for office buildings in READY.





RE production The BEST Targets concerning the on-site<sup>4</sup> Renewable Energy (RE) production in Växjö was on average 3.4 kWh/m<sup>2</sup>yr and 24 kWh/m<sup>2</sup>yr in Aarhus. The BEST target Value of on-site RE production at the RDS in Växjö and Aarhus together was 16 kWh/m<sup>2</sup>yr.

In 2019 resp. 2020, the monitored on-site RE production in Växjö was 3.2 kWh/m<sup>2</sup>yr and 7.7 kWh/m<sup>2</sup>yr in Aarhus. The floor area-weighted average value of all RDS was 5.9 kWh/m<sup>2</sup>yr.

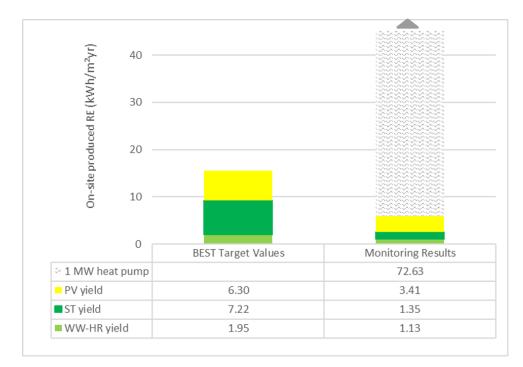
The monitoring values show that the target regarding on-site RE production was not completely fulfilled, but a 1 MW heat pump in Aarhus harbour more than compensates these shortfalls with a potential heat production of 6 GWh/yr.

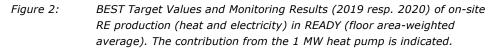
Figure 2 shows the BEST Target Values and Monitoring Results (2019 resp. 2020) of the solar heat (ST yield) and electricity (PV yield) production from roof-

<sup>&</sup>lt;sup>4</sup> Hereafter "on-site" refers only to RE production (e.g. of a PV system) at READY Demonstration Sites with a corresponding "target value" in the BEST (see DOW).

top Photovoltaic (PV) and Photovoltaic Thermal (PVT) systems as well as from Waste Water Heat Recovery (WW-HR) facilities (WW-HR yield) at the READY Demonstration Sites in Växjö and Aarhus.

The contribution from the 1 MW sea water-fed heat pump is indicated. The energy savings in the improved district heating network in Växjö and the other measures, not mentioned in this section, were not included.





RE supply to buildings Additional BEST Targets refer to the heat and electricity supply to the READY Demonstration Sites by the local district heating networks and the electricity grids from centralized renewable heat and electricity production.

At the time when the DOW was established, the use of waste heat from The New University Hospital (DNU) and the electricity production from additional common wind turbines (both in Aarhus) were suggested. These measures were not implemented within READY but in Aarhus resp. Växjö the renewable share in both, district heating (80% resp. 95%) and electricity (66% resp. 90%) is high.

Therefore, the total renewable contribution from on-site RE production and grid supply is remarkable. Additionally, the above mentioned 1 MW (first of 12 MW planned) sea water-fed heat pump at Aarhus harbour displaces the non-renewable share in READY's district heating supply.

Figure 3 shows the BEST Target Values and Monitoring Results (2019 resp. 2020) of the renewable<sup>5</sup> and non-renewable energy supply to the RDS in Växjö and Aarhus and the on-site RE production in READY. The surplus heat production of the 1 MW sea water-fed heat pump is indicated.

The energy savings in the improved district heating network in Växjö and the other measures, not mentioned in this section, were not included. The graph confirms that on an annual, project-wide view, almost no non-renewable energy is required to supply the RDS with heat and electricity.

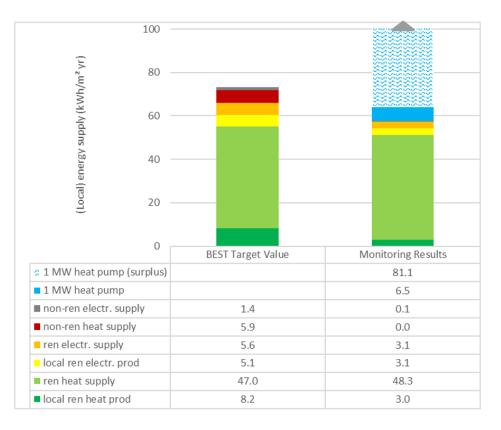


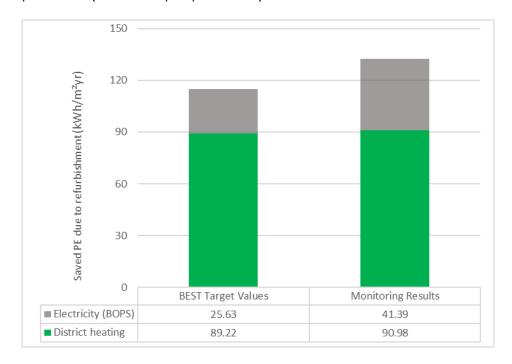
Figure 3: BEST Target Values and Monitoring Results (2019 resp. 2020) of the total renewable and non-renewable energy supply to buildings in READY from on-site RE production resp. grids (floor area-weighted average). The surplus heat production of the 1 MW sea water-fed heat pump is indicated.

Further energy savings The optimised district heating network in Alabastern/Växjö achieves a reduction in pipe heat losses of 106 MWh per year. The innovative district cooling project "energy used three times" in Växjö reduced the cooling energy consumption by 1 GWh by means of efficiency in the cooling system of the servers at a data centre and save 600 MWh cooling energy as it is provided by the heating of the football turf. As the cooling energy is provided by free cooling (from lake water), and by an absorption cooling machine (COP=0.65) which is powered by heat from the district heating network, the total saved heat is 2.5 GWh. Including the free cooling waste heat used for the football turf the total heat savings are approx. 3.1 GWh.

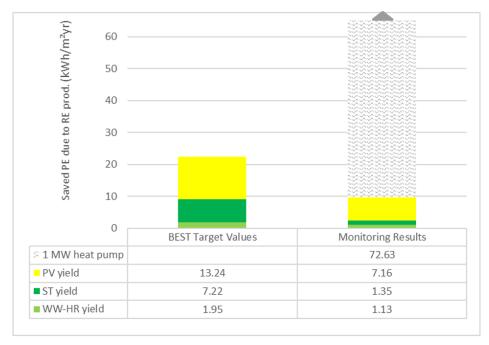
<sup>&</sup>lt;sup>5</sup> In this approach no distinction between renewable and nuclear energy was made

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Primary Energy In READY, building refurbishment leads to PE savings of 91.0 kWh/m<sup>2</sup>yr regarding heat and 41.4 kWh/m<sup>2</sup>yr regarding electricity. Figure 4 and Figure 5 show the BEST Target Values and Monitoring Results (2019 resp. 2020) regarding PE savings due to building refurbishment resp. due to on-site RE production (1 MW heat pump indicated).



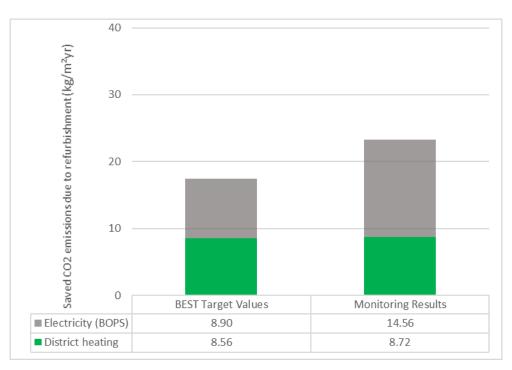
*Figure 4:* BEST Target Values and Monitoring Results (2019 resp. 2020) regarding PE savings due to refurbishment in READY (floor area-weighted average)

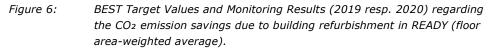


*Figure 5:* BEST Target Values and Monitoring Results (2019 resp. 2020) regarding PE savings due to on-site RE production in READY (floor area-weighted average). The contribution from the 1 MW heat pump is indicated.

 $CO_2$  emission savings

In READY, the annual  $CO_2$  emission savings regarding building refurbishment is approx. 1,668 tons<sup>6</sup>. Figure 6 illustrates the specific  $CO_2$  emission savings (per m<sup>2</sup> gross floor area) due to building refurbishment.



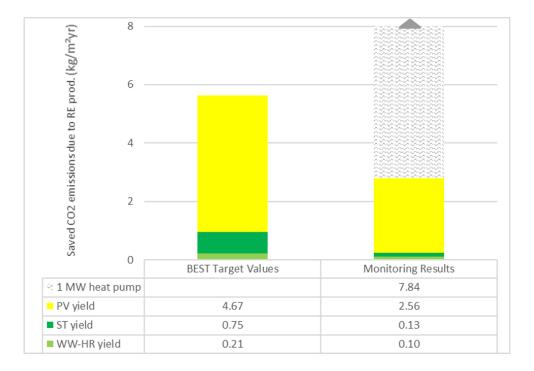


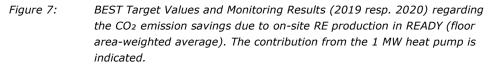
The on-site RE production (heat and electricity) lead to annual  $CO_2$  emission savings of approx. 231 tons per year. Additionally, the 1 MW sea water-fed heat pump in Aarhus harbour (Denmark) saves  $CO_2$  emissions of approx. 648 tons per year.

Figure 7 illustrates the floor area-weighted average  $CO_2$  emission savings due to on-site RE production. The contribution from the 1 MW sea water-fed heat pump is indicated. The  $CO_2$  emission savings in the improved district heating network in Växjö and the other measures, not mentioned in this section, are not included in this graph.

 $<sup>^{\</sup>rm 6}$  CO $_{\rm 2}$  emissions calculated with CO $_{\rm 2}$  emission factors defined in the DOW

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The further READY Demonstration Projects not included above contribute to  $CO_2$  emission savings as well. The optimised district heating network in Alabastern/Växjö achieves  $CO_2$  emission savings of approx. 7.9 tons per year. The  $CO_2$  emission savings of the innovative district cooling project "energy used three times" in Växjö are at least 230 tons per year.

Economic analysis The share of investment costs required to achieve the energy savings presented above was approx. 13 MEUR (166 EUR/m<sup>2</sup>) just regarding building refurbishment. The total investment costs of all facilities for on-site RE production (hereafter also referred as RES facilities) was approx. 1 MEUR excl. VAT.

> The total cost of refurbishment is significantly higher, e.g. approx. 1,500 EUR/m<sup>2</sup> for Demonstration Sites in Aarhus, as this figure includes cost for new bathrooms, new kitchens, balconies, surfaces, gardening etc. These nonenergy relevant cost shares are not part of READY and hence, not investigated in WP7.

> The EC Support for building refurbishment measures was 50% of the share of investment costs required to achieve energy savings (max. 50 EUR/m<sup>2</sup>). The EC Support for RES facilities was 50% of eligible costs of RES facilities (PVT and WW-HR systems). Standard PV systems were not supported.

In READY, the simple payback time for the energy-related investment in building refurbishment is on average 34 years resp. 25 years if the EC Support is taken

into consideration. The simple payback time for the investment in all on-site RES facilities in READY is on average 24 years resp. 15 years if the EC Support is taken into consideration.

A suitable way to analyse the cost effectiveness of energy-saving measures is to calculate the costs for the reduction of  $CO_2$  emissions (e.g. by building refurbishment). These include costs for all (additional) measures that must be performed in order to achieve  $CO_2$  emission savings: investment costs, reinvestment costs, O&M costs, etc.

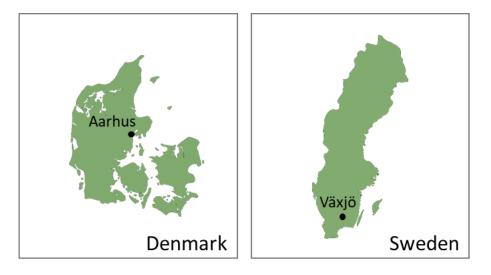
As energy savings and  $CO_2$  emission savings often come along with energy cost savings, this characteristic number may become negative, which means that the total costs to achieve  $CO_2$  emission savings are lower than the energy cost savings. Positive values on the other hand mean that the total costs to achieve  $CO_2$  emission savings are higher than the energy cost savings.

In READY, the  $CO_2$  emission saving cost of the measures regarding building refurbishment is on average -77 EUR/ton and -84 EUR/ton regarding on-site RE production. If EC Support for energy-saving measures was taken into consideration, these values would be even better. As these values are negative, on average, cost effectiveness of the READY measures could be confirmed, although this is not the case for each measure in particular.

## 2 Introduction

The objective of WP7 is to monitor the overall energy and carbon impact of the READY project as well as to monitor the energy performance of all READY Demonstration Projects.

The aim of deliverable D.7.3 is to report the results, findings and conclusions from the monitoring activities related to the READY project in Aarhus and Växjö communities, presented in Figure 8.



*Figure 8: Map representing the two demonstration communities, Aarhus in Denmark and Växjö in Sweden* 

### 2.1 READY Demonstration Projects

In Växjö and Aarhus, three resp. four READY Demonstration Projects regarding building refurbishment of residential and office buildings and eventually further energy saving measures have been monitored (see Table 1).

Code	District	Building	Measures	Gross floor
		type		area (m²)
SE1	Alabastern, Växjö	Multi-family	BEI <sup>7</sup> , VENT <sup>8</sup>	26,853
		buildings		
SE1.1	Alabastern, Växjö	Multi-family	BEI, VENT,	3,361
		building	WW-HR <sup>9</sup> , PVT	
SE3	Arabygatan 9, Växjö	Office building	BEI, VENT	3,340
DK1	District 21 Phase 1:			12,028
	Rydevænget, Aarhus	Multi-family	BEI, VENT, PV,	
	District 21 Phase 2:	buildings	WW-HR	2,123
	Rydevænget, Aarhus			
	District 21 Phase 3:	Multi-family	BEI, VENT, PV	4,528
	Fjældevænget,	buildings		
	Aarhus			
	District 21 Phase 4:	Multi-family	BEI, VENT, PV	9,623
	Fjældevænget,	buildings		
	Aarhus			
DK2	District 20	Multi-family	BEI, VENT,	19,140
	Trigeparken, Aarhus	buildings	PVT, WW-HR,	
DK3	Dybedalen 1A,	Office building	BEI, VENT, PV	1,446
	Aarhus			
DK4	Hasle/Skejby, Aarhus	Single family	BEI	174
		house		
Sum				33,554
Sum				49,062
Total				82,616

Table 1:READY Demonstration Sites in Aarhus and Växjö where building<br/>refurbishment and eventually further measures were performed

<sup>&</sup>lt;sup>7</sup> Building envelope improvement

<sup>&</sup>lt;sup>8</sup> Balanced domestic/office ventilation with efficient heat recovery

<sup>&</sup>lt;sup>9</sup> Facility for Waste Water Heat Recovery (WW-HR)

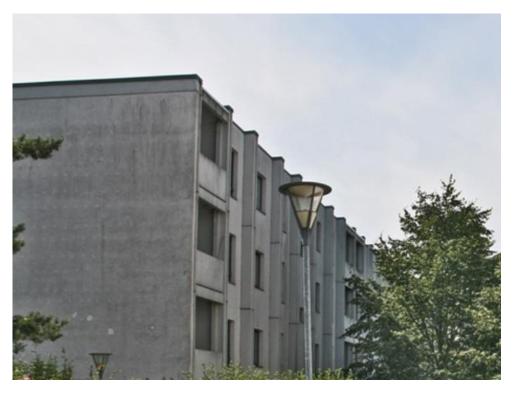
<sup>&</sup>lt;sup>10</sup> Battery Energy Storage System (BESS)

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Additionally, READY Demonstration Projects regarding district heating/cooling (RDP SE-DH<sup>11</sup> and SE-WW1 in Växjö), public charging stations for electric vehicles (RDP DK-Ch in Aarhus), and a 1 MW sea water-fed heat pump (RDP DK-WW1 in Aarhus) were established (described in 2.2).

RDS DK1 in Aarhus The first READY Demonstration Site in Aarhus is a multi-family block composed by 2 x 6 buildings called Rydevænget/ Fjældevænget, where the impact of Building Envelope Improvement (BEI), Balanced domestic ventilation with efficient heat recovery (VENT) and the performance of a PV installation have been monitored (RDS DK1).

Figure 9 and Figure 10 show the buildings in Rydevænget before and after refurbishment.



*Figure 9:* Buildings in District 21 Rydevænget/Fjældevænget, Aarhus (RDS DK1) before refurbishment<sup>12</sup>

<sup>&</sup>lt;sup>11</sup> The READY Demonstration Sites (RD<u>S</u>) have the identification codes SE1, SE1.1, SE3, DK1, DK2, DK3 and DK4 as defined in the DOW. For READY Demonstration Projects not (directly) related to building refurbishment (RD<u>P</u>), e.g. RES facilities, no identification codes had been defined in the DOW, hence, new identification codes, e.g. SE-PVT, were defined within WP7.

<sup>&</sup>lt;sup>12</sup> See <u>https://www.bf-ringgaarden.dk/se-vores-boliger/vores-afdelinger/afdeling-21/om-afdelingen.aspx</u>)

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Figure 10. Buildings in District 21 Rydevænget/Fjældevænget, Aarhus (RDS DK1) after refurbishment<sup>13</sup>

RDS DK2 in Aarhus The second monitoring site in Aarhus (RDS DK2) is a multi-family block in Trigeparken with six buildings (see Figure 11 and Figure 12), the monitored measures are the BEI, VENT an PVT system (RDP DK-PV), a Battery Energy Storage System (RDP DK-ST) and a WW-HR facility (RDP DK-WW2).



*Figure 11:* Buildings in District 20 Trigeparken, Aarhus (RDS DK2) before refurbishment

<sup>&</sup>lt;sup>13</sup> Ibid.

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*Figure 12.* Buildings in District 20 Trigeparken, Aarhus (RDS DK2) after refurbishment<sup>14</sup>

RDS DK3/4 in Aarhus The other two READY Demonstration Sites in Aarhus are an existing office building in Dybedalen 1A (RDS DK3, see Figure 13) and a single-family house in Hasle/Skejby (RDS DK4, see Figure 14). The office building was refurbished with BEI and VENT. Furthermore, the building was equipped with a roof-top PV system (RDP DK-PV). The single-family house in Hasle/Skejby (RDS DK4) was refurbished only with BEI.



*Figure 13:* Office building located in Dybedalen 1A (RDS DK3)

<sup>&</sup>lt;sup>14</sup> See <u>https://www.bf-ringgaarden.dk/se-vores-boliger/vores-afdelinger/afdeling-20/om-afdelingen.aspx</u>

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Figure 14: Single-family house in Hasle/Skejby (RDS DK4)

Further READY Demonstration Projects in Aarhus are a public charging facility (RDP DK-Ch), initial steps for a low-temperature district heating project in Harlev district (RDP DK-DH)<sup>15</sup> and a 1 MW sea water-fed heat pump at the Aarhus harbour (RDP DK-WW1).

- RDS in Växjö In Växjö, there are three RDS where several energy saving/RE production measures, similar to those applied in Aarhus were applied: building refurbishment including BEI, balanced ventilation with heat recovery (VENT), installation of a PVT system (RDP SE-PVT) and a facility for WW-HR (RDP SE-WW2).
- RDS SE1/1.1The first two RDS in Växjö are a compound of 14 multi-family buildings in<br/>Nydalavägen/Hjalmar Petris väg (RDS SE1, see Figure 15) and another multi-<br/>family building in Nydalavägen 22 (RDS SE1.1, see Figure 16).

Both RDS are located in Alabastern district. The applied measures are the BEI and the installation of centralized ventilation systems with energy efficient heat recovery (RDS SE1 and SE1.1), a PVT system at the READY Demonstration Site SE1 (RDP SE-PVT) as well as a WW-HR system at SE1.1 (RDP SE-WW2).

<sup>&</sup>lt;sup>15</sup> Representative monitoring data not yet available

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Figure 15. Monitored buildings in Alabastern, Växjö (RDS SE1) after refurbishment



*Figure 16:* Monitored building in Nydalavägen 22, Alabastern (RDS SE1.1)

RDP SE3 in Växjö Another READY Demonstration Site is located in Tvinnaren 4 (RDS SE3, see Figure 17). The building was constructed in 1945-1946 and used as a clothing factory. Today, the building is used as an office building. 3,340 m<sup>2</sup> of the second floor has been refurbished in 2017.<sup>16</sup>



Figure 17: Monitored office building located in Tvinnaren 4 (RDS SE3)<sup>17</sup>

Further RDP in Växjö

A conventional district heating network was upgraded to a low-temperature district heating network (RDP SE-DH) and an innovative project with district cooling, where by means of an cascading approach (each user uses the return from the previous user) back-cooling is performed by heating a football turf. (RDP SE-WW1, see 2.2.3)

### 2.2 Energy saving and RE production measures

### 2.2.1 Building refurbishment

In the course of building refurbishment, the thermal insulation of facades, roofs, ground floors, etc. of the buildings at the RDS in Aarhus and Växjö were enhanced, the existing windows were replaced by well insulated windows with triple-layered glazing and balanced ventilation systems with heat recovery installed in almost all buildings.

Façade insulationThe U-values of the building components of the refurbished buildings in Aarhus<br/>and Växjö before and after the building refurbishment are listed in Table 2.

16 See D.6.2

<sup>17</sup> Ibid.

	Code:	SE1/	SE1.1	D	K1	D	K2	D	КЗ	D	K4
Building component	Unit	bef.	now	bef.	now	bef.	now	bef.	now	bef.	now
External walls	W/m²K	0.36	0.33	0.70	0.22	0.70	0.15	0.70	0.15	0.70	0.10
Roof	W/m²K	0.24	0.11	0.50	0.51	0.50	0.12	0.50	0.10	0.40	0.10
Ground floor	W/m²K	0.41	0.38	0.75	0.60	0.75	0.30	0.75	0.24	0.75	0.12
Windows	W/m²K	2.50	0.90	2.90	0.56	2.90	0.80	2.90	0.80	2.90	0.90

Table 2: U-values of building components before and after building refurbishment

Air tightness Another crucial aspect of thermal building quality is the air tightness of buildings that is improved significantly in the course of building refurbishment, as performed in READY. The air tightness can be determined by means of a so-called Blower-Door test. The tested q50-values of the buildings at the Växjö RDS lie in a very good range between 0.31 h<sup>-1</sup> and 0.51 h<sup>-1</sup>. For the RDS in Aarhus, these values are not available.

Ventilation The buildings at the RDS in Aarhus and Växjö (except RDS DK4) were equipped with balanced ventilation systems with energy efficient heat recovery.

Figure 18 shows a decentralised ventilation device at READY Demonstration Site DK2 in Aarhus.



Figure 18: Ventilation heat recovery device in Building at RDS DK2

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Table 3 lists the efficiency of the heat recovery and the resulting ventilation heat losses of the buildings at the RDS after building refurbishment. The ventilation heat losses in the former building situation were not investigated, but a good rough estimate is five times the current value.

Code	ventilation rate (h <sup>-1</sup> )	efficiency of heat recovery (%)	ventilation heat losses (kWh/m², yr)
SE1 and SE1.1	0,764-0,799	81,3-86,0	unknown
SE3	5.8	74.8-78	unknown
DK1	0.3	85-88	2.7
DK2	0.3	86	2.7
DK3	0.6-1.7 (VAV)	85	6.1
DK4	0.3	no balanced ventilation	7

 Table 3:
 Ventilation efficiency values of the buildings after building refurbishment

### 2.2.2 On-site RE production (heat and electricity)

At most of the READY Demonstration Sites facilities for the production of renewable heat and electricity were installed.

PVT systems Photovoltaic thermal (PVT) systems are developed to produce both electricity and heat. This technology combines the technology of PV panels and the technology of solar collectors in one panel.

PVT systems were installed and monitored at RDS SE1.1 in Växjö (RDP SE-PVT, see Figure 19) and at RDS DK2 in Aarhus (RDP DK-PVT, see Figure 20). The installed PVT area and PV peak power of both PVT systems are found in Table 4.

RDS Code	RDP Code	District	Installed PVT area (m²)	P <sub>PV</sub> (kW <sub>p</sub> )
SE1.1	SE-PVT	Alabastern	96 in part 1	16 in part 1
DK2	DK-PVT	Trigeparken	743	126
Total			839	132

Table 4: Installed PVT area in Aarhus and Växjö



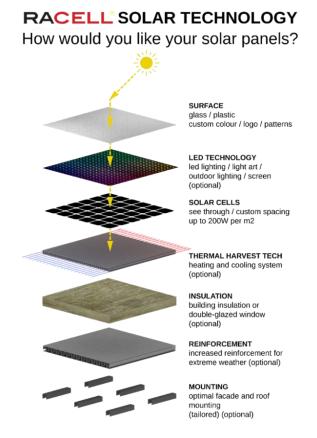
*Figure 19: PVT system (RDP SE-PVT) installed on Alabastern (RDS SE1.1), left: PVT panels, right: PV inverter* 



Figure 20: PVT system (RDP DK-PVT) installed on Trigeparken (RDS DK2)

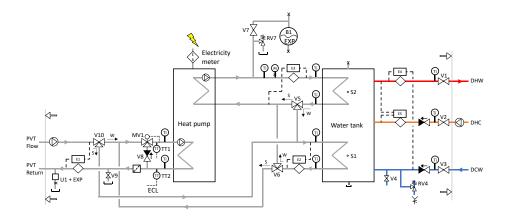
In READY, the PVT panels were supplied by RACELL, a company based in Aarhus. In contrast to conventional PVT solutions, RACELL PVT panels count with a number of innovations concerning the material characteristics (e.g. composite materials), structure and dimensions of the components (see Figure 21).<sup>18</sup>

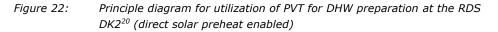
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*Figure 21:* Illustration of PVT technology<sup>19</sup> (insulation is optional)

At RDS DK1, PVT systems were installed on the roofs of three buildings. One heat pump per PVT system uses the generated heat from the collectors as a heat source for DHW preparation. The DHW is then stored in 800 litres storage tanks (one per PVT system, see principle diagram in Figure 22).



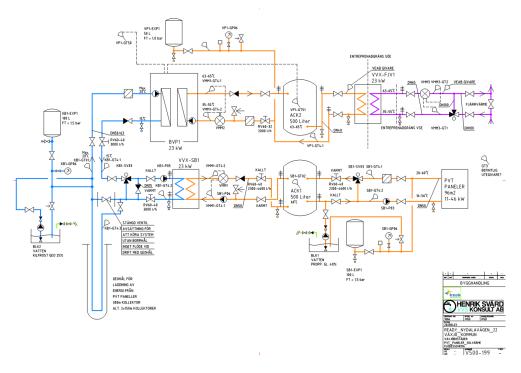


<sup>19</sup> Source: <u>http://racell.dk/products/functionality-technology/</u>, more general information on the technology: D.8.5 Replicability assessments for READY solutions

#### <sup>20</sup> D.3.1.1

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The heat from the PVT system at RDS SE1.1 is first stored in the ground via geothermal probes and then serves as heat source for DHW preparation. The DHW is stored in a 500-litre storage tank (see Figure 23).



*Figure 23:* Principle diagram for utilization of PVT for DHW preparation in a ground source hybrid system at the RDS SE1.121

PV systems Besides innovative PVT systems, conventional Photovoltaic (PV) systems were installed (without EC Support). The PV systems are located on top of the buildings in Rydevænget (RDS DK1, see Figure 24), in Trigeparken (RDS DK2) and Dybedalen 1A (RDS DK3, see Figure 25) and count with a total installed area of approx. 1,877 m<sup>2</sup> resulting in an installed peak power of approx. 346 kW<sub>p</sub> (see Table 5).

Code	District	Installed PV area (m²)	P <sub>PV</sub> (kW <sub>p</sub> )
DK1	Phase 1&2 (Rydevænget)	844	157
DK1	Phase (Fjældeevænget) <sup>22</sup>	822	153
DK2	Trigeparken	82	14
DK3	Dybedalen 1A	129	22
Total		1,877	346

<sup>21</sup> Henrik Svärd VVS Konsult AB, 16.03.2020, technical drawing V500-199

<sup>22</sup> Not included in Monitoring Results

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*Figure 24:* View of the installed PV system on the roof of a multi-apartment building in Rydevænget (RDS DK1)



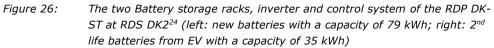
*Figure 25:* View of the installed PV system on the office building's roof in Dybedalen 1A (RDS DK3)

Battery storageAt the READY Demonstration Site DK2 (Trigeparken) a Battery Energy Storage<br/>System (BESS, RDP DK-ST) was installed by Lithium Balance A/S. It consists of<br/>one central 40 kW inverter connected to two battery racks, one with four new<br/>Nissan cells with a total capacity of 79 kWh and one rack with 2<sup>nd</sup> life cells<br/>(GEN 1) with a total capacity of 35 kWh. (see Figure 26).23

<sup>&</sup>lt;sup>23</sup> See D.5.1.1

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The purpose of the battery plant at Trigeparken is to optimize the utilization of on-site RE production at the apartment housing. The plant management uses also demand side management in the control scheme.

The 40 kW/114 kWh battery system is installed in parallel with the 135 kW PV system and in parallel with the distribution installation (see Figure 27).

The battery system can in principle also supply energy to the electricity grid through the POC (Point of Connection). However, the delivery to the electricity grid is only expected to occur when the PV production is larger than the energy demand and the battery system's remaining storage capacity.

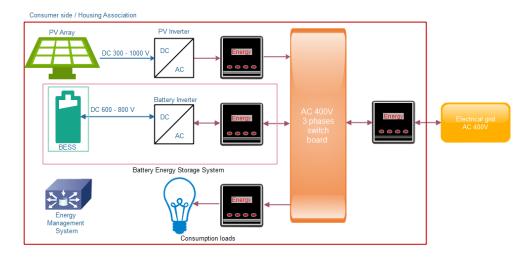
The monitoring of the Battery Energy Storage System includes the actual power produced by the PV system, the actual (feed-in) power fed into resp. taken from the grid, the building's actual power consumption and the batteries' state of charge. The BESS' technical properties are listed in Table 6.

<sup>24</sup> Ibid

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Table 6: Properties of the BESS (RDP DK-ST) at RDS DK2

Inverter – producer	ABB	
Inverter – model	ESI-S type 4	
Inverter – nominal power	3 x 60 A $\sim$ 40 kW into the installation	
Battery pack – producer	Lithium Balance	
Battery pack – model nr.	Xolta – 1 x 79 kWh + 1 x 35 kWh DC- rack (et rack) LiIon	
Battery pack – energy storage capacity, with nominal inverter power at POC [kW/h]	110 kWh of usable energy (114 kWh nominal battery capacity)	
Battery pack – runtime at rated inverter power at POC [KW/h]	80 minutes at 40 kW	



*Figure 27:* Principle diagram of the Battery Energy Storage System (RDP DK-ST) at RDS DK2

The BESS is monitored, the parameters battery charging state, PV production, electricity consumption and grid contribution (import or export) and the 24 h self-power rate are displayed on a dashboard (see Figure 28).



Figure 28: Monitoring dashboard with parameters of the RDP DK-ST at RDS DK2

WW-HR The WW-HR facilities were developed by ECO Clime and were installed in Aarhus (Trigeparken and Rydevænget) and Växjö (Alabastern District), see Table 7. The technology aims at recovering heat from wastewater from multi-family buildings, where the waste water flow is stable. The system consists of a waste water storage tank, a special heat exchanger and a heat pump that pre-heats DHW for a DHW tank (see Figure 29). A Principle diagram and an image of the prefab plastic manhole of the WW-HR facility in Aarhus are shown in Figure 30 resp. Figure 31.

Code	District	Capacity (kW <sub>th</sub> )
SE1.1	Alabastern	15
DK1	Rydevænget	2
DK2	Trigeparken	8
Sum SE		15
Sum DK		10
Total		25

 Table 7:
 READY Demonstration Sites with WW-HR and installed capacity



*Figure 29:* Innovative WW-HR facility (RDP DK-WW2) at RDS SE1.1. Heat exchanger module to the left, pumping unit in the middle and buffer tank with stirring device to the right. All done as prefab and pre-insulated manholes.<sup>25</sup>

<sup>&</sup>lt;sup>25</sup> VXH-SE

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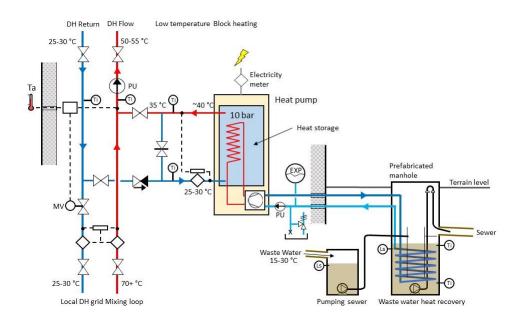


Figure 30: Principle diagram of the WW-HR facility at RDS DK2<sup>26</sup>



Figure 31: Prefab plastic manhole with integrated heat exchanger at RDS DK2<sup>27</sup>

#### 2.2.3 Further energy saving and efficiency measures

Besides the energy efficiency measures related to building refurbishment (RDS SE1-3, DK1-4), and on-site RE production (e.g. RDP DK-PVT) further READY Demonstration Projects (RDP) have been established.

EV charging stations In Aarhus, mainly in the city centre and industrial areas, EON has implemented 54 Electric Vehicle (EV) charging poles with each two sockets à 11 kW charging

<sup>&</sup>lt;sup>26</sup> COWI

<sup>&</sup>lt;sup>27</sup> Ibid

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capacity (RDP DK-Ch). The total charging capacity of all EC Charging Stations is 2.3 MW. The installation cost/EC Support was EUR 480,307 resp. EUR 230,876 excl. VAT.

The charging stations are installed in the public street and they are capable of charging car batteries in approx. three hours.<sup>28</sup> In READY, further aspects of mobility were assessed, but WP7 focuses on the supplied electricity to the EVs and the utilization rate of the charging poles only. Figure 32 shows one of the 54 EV charging poles in Aarhus.



Figure 32: Example picture of charging pole of RDP DK-Ch in Aarhus<sup>29</sup>

District heating

In the Alabastern district in Växjö, the supply/return temperatures of the district heating (DH) network (RDP SE-DH) were reduced to approx. 65/35°C. The objective was to decrease the pipe heat losses by approx. 60% (see Table 8).

The monitoring focuses on the heat supply to the district and the total heat consumption of all consumers. This allows to calculate the key indicator values, such as the total pipe heat losses and as a percentage of the total district heating supply. Figure 33 shows the network plan of the optimised district heating network in Alabastern.

 $<sup>^{\</sup>rm 28}$  See D.8.5 and D.5.5.2

<sup>&</sup>lt;sup>29</sup> D.5.5.2

Table 8:	Basic planning parameters of the optimised district heating network in
	Alabastern (RDP SE-DH)

Length of district heating network (m)	582
Max. district heating capacity (kW)	300
Max. specific district heating capacity (kW/km)	500
Panned district heating supply temperature (°C)	65
Planned district heating return temperature winter (°C)	22
Planned district heating return temperature summer (°C)	38
Baseline district heating supply temperature winter (°C)	90-105
Baseline district heating supply temperature summer (°C)	65
Baseline district heating return temperature (°C)	50
Annual district heating supply (GWh)	1,6
Specific annual district heating supply (GWh/km)	2.7
Planned pipe heat losses (%)	5
Baseline - pipe heat losses of conventional DH network	12
Planned pipe heat loss reduction (%)	60

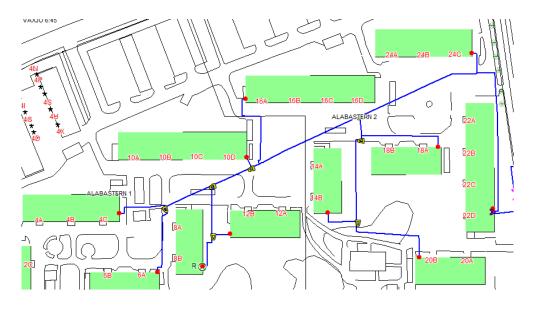
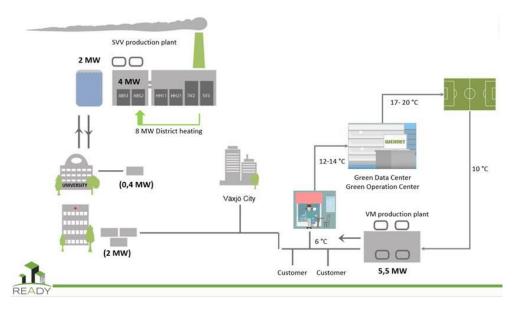


Figure 33: Network plan of district heating network in Alabastern district<sup>30</sup>

<sup>30</sup> VXH-SE

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- District cooling An innovative district cooling (DC) project in Växjö (RDP SE-WW1) "energy used three times", utilizes the DC flow twice for cooling and once for heating. The process is explained below and illustrated in Figure 34.
  - 1. Air conditioning for shopping mall Grand Samarkand
    - DC supply temperature: 6 to 10°C
    - DC return temperature: 12 to 14°C
  - 2. Server cooling at Wexnet's data centre
    - Innovative server room design, server positioning and air flow design allow higher DC supply temperatures: 12 to 14°C
    - Therefore, the DC return from the shopping mall can be used as cooling supply for the server cooling
    - Return temperatures: 17-20°C
  - 3. "Heating" of football turf of football stadium at Myresjöhus Arena
    - DC return from the data centre serves as "heating" supply releasing heat to the football turf. This extends the outdoor training season significantly
    - Football turf's "heating" return temperature: 10-12°C
    - DC water returns to the cooling plant
  - 4. Cooling plant
    - Reduced heat consumption for the absorption chiller due to "free cooling" via football turf
    - Refrigeration plant partly powered by PV-panels



*Figure 34:* Illustration of the innovative district cooling/"heating" network<sup>31</sup> (RDP SE-WW1)

<sup>&</sup>lt;sup>31</sup> D.6.4 VEAB-SE

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1 MW heat pump In Aarhus, a 1 MW sea water-fed heat pump contributes to the heat supply of the district heating network (RDP DK-WW1). At the AffaldVarme site, the new heat pump (see Figure 35 and Figure 36) almost fully replaces a traditional heat pump and oil boiler, significantly decreasing the previously required amount of oil.



Figure 35: Water chiller installation of the 1 MW sea water-fed heat pump (RDP DK-WW1)



*Figure 36:* Ammonia chiller installation of the 1 MW sea water-fed heat pump (RDP DK-WW1)

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The 1 MW sea water-fed heat pump is used for grid congestion management and power grid control, increasing the energy efficiency of the overall energy system: the heat pump operation is adapted to the volatile electricity production from RES which helps to integrate RES and to reduce congestions in the electricity grid. Furthermore, the heat-bound electricity production at CHP plants is reduced as the heat can be provided by the heat pump instead.

The heat pump can operate approx. 6,000 full-load hours per year resulting on a heat production of 6 GWh. The monitoring focuses on the hourly heating capacity/power input and the monthly resp. annual heat production/electricity consumption. The key performance indicators derived from the monitoring data are the coefficient of performance (COP) at certain operation modes resp. heat source/sink temperatures and the monthly and annual seasonal performance values (for various boundaries).

# 3 Methodology of energy monitoring

## 3.1 Monitored energy parameters

The "Smart Cities Information System - Technical Monitoring Guide"<sup>32</sup> prepared by Smart Cities Information System (SCIS)<sup>33</sup>, is the basis of the methodology of energy consumption monitoring. In the monitored parameters, all energy meters are included in order to document the total Final Energy consumption<sup>34</sup> of the building or energy production at the RES facilities.

Monitoring data were usually collected as monthly values during a period of several years. In some cases, (reliable) monitoring data were available not for every month, e.g. due to issues during initial operation phases. Then, the values were extrapolated in order to get annual consumption values of a fictitious reference year.

# Levels of details Two levels of details on metering were performed on the demonstration buildings, see Table 9.

Level 1 – Building level		Level 2 – Individual level (in some ca	ases)
Space heating	kWh	Mean indoor air temperature	°C
Domestic Hot Water (DHW)	kWh and m³	Space heating for selected apartments –	kWh
Electricity (BOPS)	kWh kWh	Electricity for households in groups of app. 20 apartments – kWh Electricity for ventilation in selected apartments	kWh
Electricity for technical rooms	kWh		
Heat Production from PVT panels	kWh		
Production from PV panels	kWh		
Heat production from heat pumps			
Electricity consumption of heat pumps			
Energy recovered from waste water	kWh		
Cold water	m³		

 Table 9:
 List of metering points for the buildings in Aarhus and Växjö

Figure 37 shows an example of monitoring data output from MinEnergi which provides the energy monitoring system for Dybedalen 1A (RDS DK3).

<sup>32</sup> <u>http://www.smartcities-infosystem.eu/sites/default/files/document/technical-</u> monitoring-guide\_2016.pdf

<sup>33</sup> Continued in another scheme since end of 2020

<sup>34</sup> total heat and common electricity consumption

				Følgen	de målere er	oprettet på Administrationen			2
Ejendomsbetegne	else:	Administratione	n			*			
Adresse:		Dybedalen 1A						Billed	
Anvendelse:		320 / 5400 / (U	Inder	udfasning) Kontor		•		Dokume	enter
BBR-nummer / B	/ggeår:	751 - 781457	- 00	1	1989	13			
Totalt areal / Opv	armet areal:	2.068		1.345	*	C matrix	Contraction of Contract		
Slut måned Varm	e / vand / EL:	December	۲	December v	December		A DESCRIPTION		
CVR-nummer / P	nummer:					III ME	1-20		
EAN-nummer:						A STATE OF THE OWNER			
						A DECISION OF THE OWNER OWNER OF THE OWNER			
Bygnings ID:									
Bygnings ID: Unik ID	ID	E-form	т			Målerbelegnelse		Leverandør	Aflæsninger
	ID ?	E-form	Т	_	_	Målerbetegnelse		Leverandør	Aflæsninger
Unik ID		?			A, 601356, FJV I	2			
Unik ID	2	RWh	2			2		?	-
Unik ID ? 17876	1	RWh m3	2	<ul> <li>Dybedalen 1A</li> <li>Dybedalen 1A</li> </ul>		Dybedalen 1A		Ârhus Kom	Aflæsninger
Unik ID ? 17876 17877	? 1000	kWh m3 m3	2 1	<ul> <li>Dybedalen 1A</li> <li>Dybedalen 1A</li> <li>Dybedalen 1A</li> </ul>	A, 14515547	Dybedalen 1A		Arhus Kom	Aflæsninger
Unik ID ? 17876 17877 17878	1 1000 2000	kWh m3 m3 kWh	2 1 1	<ul> <li>Dybedalen 1A</li> <li>Dybedalen 1A</li> <li>Dybedalen 1A</li> </ul>	A, 14515547 n 1A, Varmt brug A, 119334, 1035	Dybedalen 1A		Århus Kom Århus Kom Århus Kom	Aflæsninger Aflæsninger Aflæsninger
Unik ID 7 17876 17877 17878 17878 17879	1 1000 2000 3000	kWh m3 m3 kWh kWh	2 1 1 1	<ul> <li>Dybedalen 1A</li> <li>Dybedalen 1A</li> <li>Dybedalen 1A</li> <li>Dybedalen 1A</li> <li>Dybedalen 1A</li> <li>EL-Boligne</li> </ul>	A, 14515547 n 1A, Varmt brug A, 119334, 1035	Pybedalen 1A gsvand (5759)		Arhus Kom Århus Kom Århus Kom NRGI	Aflæsninger Aflæsninger Aflæsninger Aflæsninger

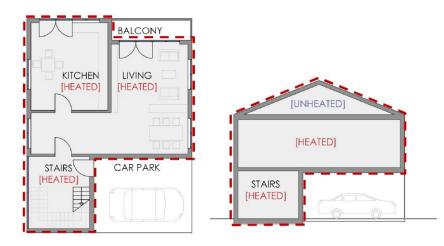
*Figure 37: Example of monitoring data output from MinEnergi in Dybedalen 1A (RDS DK3)* 

# 3.2 Conventions

#### 3.2.1 Floor area and volume definition

In the Monitoring Data sheets, the SCIS floor area definitions for gross area are used in order to enable comparison of the energy performance indicators between buildings from different EU countries. Aarhus and Växjö use the same definition of floor area as defined by SCIS.

Area/volume definition Gross Floor Area and Volume are calculated according to the SCIS conventions. According to these conventions, the outside borders of the building and building envelope define the gross floor area and volume. All floor areas in all levels including secondary rooms and external walls are considered and the building volume including all these areas and external walls are considered. The area of balconies, patios and parking spaces is excluded (see Figure 38).



*Figure 38: Gross Floor Area and Volume conventions example* 

https://cowi.sharepoint.com/sites/A064318-project/Shared Documents/03 Deliverables/04 Reporting/07 WP7/D.7.3/04 Final Documents/D7.3 Evaluation of the operational monitoring data of the demonstration projects\_v2.4 final.docx

## 3.3 Normalisation of energy consumption

#### 3.3.1 Normalisation to weather conditions

Normalisation of the heating consumption corresponding to that of an average climate year is necessary when one wants to compare the heating consumption of a building in different years. This report compares the energy consumption in a monitored period with the energy consumption stated in the BEST (Building Energy Specification Table) and must therefore be normalised. Normalisation of data follows a standard normalisation technique. The heating data are normalised using the official Danish resp. Swedish degree-days, as they are comparative to the number of annual degree-days in a reference year that the BEST states (see Appendix B – BEST).

The Danish degree-days are measured and managed by the Danish Technological Institute (DTI) at a monitoring station at Landbohøjskolen in Copenhagen.<sup>35</sup>

The Swedish degree-days are measured and managed by the Swedish Meteorological and Hydrological Institute at a monitoring station in Växjö.

According to DTI, who is the Danish contact point on degree-day information:

Definition of degreedays

> "One degree-day is an expression of the difference of 1°C between the presumed indoor average temperature of 17°C and the outdoor average temperature in one day and night. "<sup>36</sup>

The temperature of 17°C is used as it is assumed that the internal heat load contributes with the last 3°C up to the <u>reference temperature of 20°C</u>, which is the design indoor design temperature in Aarhus. Moreover, the prerequisite of 20°C indoor temperature was used to define the energy consumption targets in the BESTs in the DOW as it is the temperature used in the Danish Energy Labelling System and in the documentation of energy frames according to the Danish Building Regulations, valid for the actual buildings.

Example (indoor temperature 20°C):

+2°C outdoor temperature gives 17-2°C x 1 day=15 degree-days per day -5°C outdoor temperature gives 17-(-5) °C x 1 day = 22 degree-days per day

If the indoor air temperature is higher than 20°C, for instance 22°C, then a normalisation back to reference temperature is necessary as explained in section 3.3.2.

<sup>&</sup>lt;sup>35</sup> See <u>https://www.teknologisk.dk/ydelser/graddage/pressemeddelelse/492</u>

<sup>&</sup>lt;sup>36</sup> See <u>http://www.teknologisk.dk/graddage/hvad-er-graddage/492,3</u>

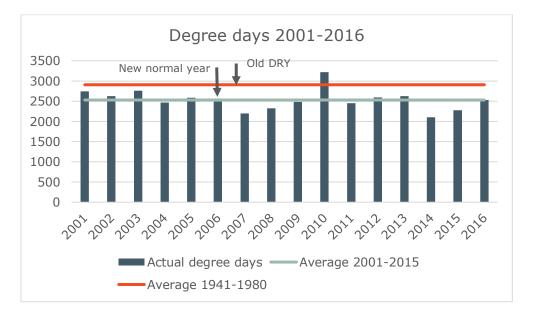
https://cowi.sharepoint.com/sites/A064318-project/Shared Documents/03 Deliverables/04 Reporting/07 WP7/D.7.3/04 Final Documents/D7.3 Evaluation of the operational monitoring data of the demonstration projects\_v2.4 final.docx

DRY and new

normal year

The official Danish Design Reference Year (DRY) was performed by Danish Technological University and is based upon 20°C indoor temperature. It consists of an average of data collected in the period 1941-1980 and contains many parameters such as outdoor temperature, relative humidity, wind speed and direction, hours of sunshine etc. The DRY has 2,906 degree-days. Because of climate changes, the average of degree-days in the period 2001-2016 has only been 2,529 degree-days, see Figure 39. After a period of voluntariness, in Aarhus since 2015 it is mandated by the Danish Building Regulations to use updated climate data starting in 2001. This means that the old DRY is not used anymore.

In READY, average degree days were calculated of the degree days values of the period 2001-2019 for both Aarhus and Växjö. The monitoring data was normalised according to these values in order to produce as realistic values as possible.



*Figure 39:* Degree-days measured by Danish Technological Institute in the period 2001-2016. The lines are the Danish Reference Year (1940-1982) in red and the new reference based on average of years between 2001 and 2016 (exemplary) in yellow.

Example - weather conditions

The normalisation of heat energy consumption in relation to the outdoor climate is carried out as shown in the example below. Only one year is presented in the fact sheets and only this year is normalised.

Space heating consumption, 2019: 100 kWh/m<sup>2</sup> (metered value)

Degree-days normal year (20°C): 2,528 (2001-2019)\*

Actual degree-days in 2019 (20°C): 2,237 \*

Normalisation, space heating:

 $100 \ kWh/m^2/2237 \ * \ 2528 = \frac{113 \ kWh/m^2}{100 \ kWh/m^2}$ 

\* (from DTI's monitoring station in Copenhagen)

#### 3.3.2 Normalisation to indoor reference temperature: Definition of indoor temperatures

The normalisation of heat consumption in relation to the outdoor climate presumes an indoor air temperature of 20°C (see section 3.3.1). Experience shows that inhabitants often have more than 20°C in actual room temperature, especially when they live in a low energy house. It was assumed that at the monitored READY Demonstration Sites the actual indoor temperature (during the heating period) in multi-family buildings has been 22°C (RDS in Växjö and RDS in Aarhus) and 23°C in office buildings (RDS in Växjö and Aarhus).

Calculating degreedays The consequence of keeping such a high indoor temperature is a higher energy consumption than calculated. For every degree, a resident keeps the average indoor temperature above 20°C in the heating season, the number of total degree days will rise equally, approximately by 5% per degree. The energy consumption is therefore approx. 15% higher when keeping 23°C instead of 20°C. To compare the actual heating consumption with the BEST Target heating consumption, the additional heating consumption caused by a higher indoor temperature must be normalised. The method for this is to add one degree-day per day for every degree the indoor temperature is higher than 20°C. See example:

Example (indoor temperature of 22°C):

+2°C outdoor temperature gives 17+2-2°C x 1 day = 17 degree-days per day. -5°C outdoor temperature gives 17+2-(-5)°C x 1 day = 24 degree-days per day.

As the example shows, the number of degree-days increases with increased temperature. Table 10 shows a list of the Danish Reference Year compared with degree-days from 2019 at indoor temperatures from 20-24°C. Specifically, 1 degree-day per day in the month was added when adjusting the year from 20°C to 21°C, 2 degree-days per day in the month at 22°C, etc.

	Norma	alisation to wea conditions	ather	Normalisation to reference indoor temperature (extra degree-days/month)						
	DRY 1941-1980	Normal year 2001-2019	2019 (20°C)	2019 (21°C)	2019 (22°C)	2019 (23°C)	2019 (24°C)			
January	525	477	460	31	62	93	124			
February	480	437	338	28	56	84	112			
March	460	460	460	460	460	460	408 342 31 62	62	93	124
April	302	229	160	30	60	90	120			
May	79	31	109	31	62	93	124			
June	1	1 0		0	0	0	0			
July	0	0	0	0	0	0	0			
August	0	0	0	0	0	0	0			
September	36	15	20	30	60	90	120			
October	219	189	137	31	62	93	124			
November	349	315	303	30	60	90	120			
December	455	427	368	31	62	93	124			
Total	2906	2528	2237	273	546	819	1092			

Table 10:The old Danish Reference Year 1941-1980 (DRY), the new normal year<br/>2001-2019 and the annual degree-days from Danish Technological<br/>Institute including additional degree-days at higher indoor temperatures.

Example - indoorThe normalisation of heat energy consumption in relation to the indoor referencereference temperaturetemperature is carried out as the following example shows:

Space heating consumption, 2019:	100 kWh/m	<sup>2</sup> (metered value)
Degree-days normal year (20°C):	2,528 (200)	1-2019)*
Additional actual degree-days in 201	9 (23°C):	819 (see Table 10)*
Normalisation, space heating:		
100 kWh/m²/(2,537+819) * 2528 = <u>75</u>	<u>kWh/m²</u>	

\* (from DTI's monitoring station in Copenhagen)

# 3.4 Example of normalising heating consumption

To clarify the method for normalising the heating consumption, a complete example will follow from a building block. The monitored data consists of values from <u>direct meter readings</u> and values that <u>derives from meter readings</u> (more information on derived data later). The building is supplied with district heating and has four heat meters and one electricity meter:

- > Total delivered heat (kWh)
- > DHW (kWh)
- > DHW circulation losses (kWh)
- Space heating (kWh)
- Total building electricity for common lightning, centralized ventilation, etc. (kWh)

#### Presentation of data The data are presented in the appendix with fact sheets like the example in Figure 40 shows – more data are available in the monitoring spreadsheets. The red boxes and black text highlights directly read monitored data from meters and the other data are either normalisations, summarisations or subtractions.

Address							vy dalavägen 2									1
Typology o	of Dwelling						ty canaragon 2						1			
Occup ants i	-												1			
Occup ants 1													1			
- receiption of	.ypc		<u> </u>										1			
Ownership																
Guss floor	area (m <sup>2</sup> )						202				-			_		
CIECU A TREA	Energy						1	Messued	Values Her	at			Measured Valu	es Electricity	Measured V	alues Water
						Diff value	Total			DHW		Space				
	Total	Total/m <sup>2</sup>		T ot delivered heat.		Space heating	delivered	DHW	DHW	circulation	Space	heating	Totalbuilding		Cold water	Hot water
Monito-				incl.los.ses(corr.)	incl.los.ses(corr.)	(con)	heat			los ses	heating	(correct.)	elec	elec		
ning											~					
Period	kWh	kWh/m <sup>2</sup>		kWh/m <sup>2</sup>	kWh	kWb	kWh	kWh	kWh/m <sup>2</sup>	kWh	kWh	kWh	kWh	kWh/m <sup>2</sup>	m	m <sup>3</sup>
Jan 18	23,768	12			22,550	28	22,522	3,468	2	663	16010	16,03	1,218	1	146.97	59.8
Feb 18	21,816	11		10	20,724	-2,763	23,487	3,459	2	622	17,180	14,41	1,092	1	143.93	59.64
Mrr 18	21,139	10		10	19,979	-3,647	23,626	4,142	2	682	16050	12,40	1,160	1	171.27	71.42
Apr 18	14,674	7		7	13,632	-194	13,826	3,959	2	647	6720	6,52	1,042	1	171.88	68.26
Mai 18	9,064	4		4	8,030	543	7,487	3,689	2	630	1,130	1,67	1,034	1	179.14	63.61
Jun 18	7,102	3		3	6,087	637	5,450	3,057	2	588	440	1,07	1,015	0	154.49	52.71
Jul 18	5,960	3		2	4,910	507	4,403	2,401	1	565	40	54	1,050	1	155.29	41.39
Ang 18	6,887	3		3	5,773	261	5,512	2,863	1	581	610	87	1,114	1	121.19	49.37
Sep 18	8,819	4		4	7,568	-336	7,904	3,228	2	588	2,550	2,21	1,251	1	139.13	55.65
Okt 18	13,051	6		6	11,916	-65	12,601	3,263	2	635	6950	6,26	1,135	1	140.65	56.26
Nov18	17,868	9		8	16,740	-513	17,253	3,448	2	629	11,120	10,60	1,128	1	148.6	59.44
Dez 18	22,308	11		10	21,076	26	21,050	3,035	1	655	14,190	14,210	1,232	1	130.8	52.32
TOTAL	172,456	85		78	158,985	-6.136	165,121	40,012	20	3,779	92,990	86.85	13.471	7	1.803	690
Jan 19	23.505	12			22,356	-1,511	23,867	6,257	3	670	16940	15,42	1,149	1	159.16	54.28
Feb 19	21,028	10		10	20,047	1,454	18,593	5,270	3	583	12740	14,19	981	0	159.16	50.38
Mn 19	20,303	10		9	19,260	229	19,031	5,865	3	646	12520	12,74	1,043	1	159.16	57.81
Apr 19	13,405	7		6	12,426	- 134	12,560	5,381	3	609	6570	6,43	979	0	159.16	54.04
Mai 19	9,914	5		4	8,882	-1,464	10,346	5,430	3	616	4300	2,83	1,032	1	162.85	57.28
Jun 19	6,605	3		3	5,615	365	5,250	4,565	2	565	120	48:	990	0	163.39	51.96
Jul 19	5,767	3		2	4,738	-71	4,809	3,879	2	570	360	28	1,029	1	150.19	43.56
Au = 19	5.993	3		2	4,945	97	4,848	4,065	2	573	210	30	1,048	1	150.94	46.79
Sep 19	8.625	4	-	4	7,594	-663	8,257 13.302	4,708 5,633	2	559 599	2990 7070	2,32	1,031	1	157.29	53.84
Okt 19	13,468	7		6	12,374	-928	13,302 16,680	5,653	3	599	10580	6,14	1,094		169.79 157.95	61.76 59.17
Nov 19	17,316	9	-	8	16,229	-421	19,391	5,706		635	13,050	10,15	1,087			
Dez 19	21,542	11		10	20,360	969			31			14,019	1,182		159.84	59.07
TOTAL	167,472	82		76	154,827	-2,077	156,904	62,228	31	7,226	87,450	85,37	12,645	6		650
2018 KEADY BE	ST (k Wh/m 2) 172.456	160 85		149 78				21 20						11		
2019	167,472	82	I	76				31						6		I

*Figure 40:* Monitoring spread sheet with monitoring data from a multi-family building. Red boxes highlight the directly read monitoring data. Other data are normalisations, summarisations or subtractions.

https://cowi.sharepoint.com/sites/A064318-project/Shared Documents/03 Deliverables/04 Reporting/07 WP7/D.7.3/04 Final Documents/D7.3 Evaluation of the operational monitoring data of the demonstration projects\_v2.4 final.docx

Derivation of data Figure 41 illustrates the total energy consumption at RDS DK2 in 2019 and how it is obtained from the different energy categories. The total heating consumption, which is read from the district heating meter, includes both space heating, heating of DHW and heat losses from distribution pipes. As only the space-heating share is subject to normalisation to weather and reference temperature, this must be identified, see procedure after the figure.

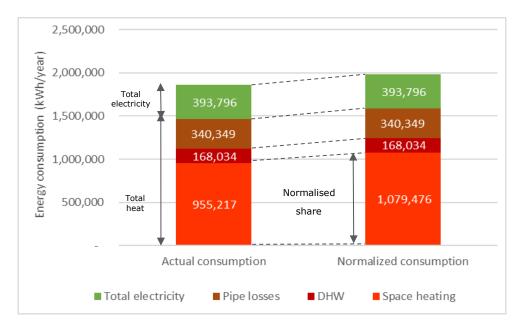


Figure 41:Breakdown of total energy consumption (electricity and heat) into<br/>categories: Space heating, DHW and electricity (RDS DK2, year 2019)

The derivation of data follows this principle:

- 1 Total heating heating for DHW = Space heating incl. pipe heat losses
- 2 Space heating incl. pipe heat losses pipe heat losses = Space heating

Space heating The monitored data consist of values from <u>direct meter readings</u> and values that <u>derives from meter readings</u>. I.e. if:

A + B = C and

- C is a direct meter reading of **total heating**
- B is a direct meter of **DHW** (kWh or m<sup>3</sup>)

then

A is **space heating** and <u>derives</u> from monitored data.

The data derivation and analysis included normalisation of the heating consumption. Only the heating energy consumption needs to be normalised as it can be assumed that the DHW consumption and Pipe heat losses are approximately equal for every month – summer as winter.

# DHW The DHW consumption is metered directly and has not undergone any adjustments.

Pipe heat losses The pipe heat losses are the remaining heat consumption that can't be ascribed to either space heating or DHW consumption. Therefore, the Pipe heat losses can be identified from the three summer months where there is no space heating demand. The heat losses from pipes are almost constant during the year as hot water circulates constantly. In wintertime, the heat loss from pipes may contribute to heating of the building, depending on the location of pipes and is not a complete loss, but in summertime, the heat cannot be utilised, and losses can be significant.

Detailed derivationWhen Pipe heat losses are identified, the final conversion and normalisation of<br/>data can be conducted. In general, the conversion, derivation and normalisation<br/>of data follows this example of method, month by month:

Processing of monitored data per month (For instance DK 2 in January 2019)

<u>Total district heating – heating of hot water:</u> 257,957 kWh – 14,343 kWh = 243,614 kWh

DHW: 14,343 kWh

Pipe heat losses (average of Jun-Aug): 28,362 kWh

#### Actual space heating:

Actual space heating = Total heating – DHW – Pipe heat losses (257,95 – 14,343 - 28,362) kWh = 215,252 kWh

<u>Normalised space heating:</u> Normalised space heating = Actual space heating/(degree-days in January 2020+ additional degree-days for indoor temperature of 23°C) x degree-days in January in normal year 215,252 kWh/(460 + 93) x 477 = 185,669kWh

## 3.5 Guide to monitoring fact sheets in appendix

The appendix of this report consists of a 1-2 pages monitoring fact sheet for each of the buildings and one sheet per RES facility. The fact sheets present in a visual easy way all the relevant information of the demonstration such as general data, building characteristics and key energy figures. To each building fact sheet belongs an overview table of the monitored data and the procession hereof. Figure 42 shows an example monitoring fact sheet with indicators of the information categories, as listed below.

#### No. Content

- General data (Address, area, year of construction, investment costs etc.)
- 2 Short description of the performed measures (Insulation thickness, glazing type etc.)
- 3 U-values defined in BEST, target figures and actual obtained U-values
- 4 Information on the energy system
- 5 Reference energy consumption according to BEST
- 6 Target energy consumption according to BEST and calculated design values.
- 7 Actual monitored values per m<sup>2</sup> gross heated area in the specific period and the same values normalised for 2019 resp. 2020

Conoral Data							
General Data					Rydevæ	nget 105-1	.31, Adi
Refurbished Building	District 21 - Rydevænget						
Year built	1970-1973	7	_				
Year refurbished	1990	Dunner	-				
Address	Rydevænget				_		
Building function							and instantion of the local diversion of the
Building type	Social hou: 1						
Number of Apartments	163						and the second s
Number of Occupants							
•	Approximately 400						
Gross Floor Area (m²) Gross Volume (m³)	<b>14.151</b> 39.623						
Net Heated/Cooled Area (m <sup>2</sup> )	11.321						
Net Heated/Cooled Volume (m <sup>3</sup> )	28.302						
Basement Type	Parterre				THE REAL		TIT
Attic Type		The second second second		1		W P	1 . Fre
Total Investment cost [Euro]	Roof apart., piched w. PV 9.86 mio. (VAT excl.)	Contraction of the			and the second second		
	9.80 IIIO. (VAI excl.)	and the second second	6			and the second second	And in case of the local division of the loc
Ruilding Footures			Defeue		Project Target	Desim	Actu
Building Features	Concrete sandwich + ext.	W/m²K	Before 0,70	practice 0,30	(BEST) 0,15	Design 0,17	(2019/ 0,12-0
xternal walls Roof	Wooden structure + sheet		0,70	0,30	0,15	0,17	0,12-0
Ground floor	- Sileel	W/m <sup>2</sup> K	0,50	0,20	0,10	0,12	0,09-0
	- Aluminum/wood frame	W/m²K					
Windows (frame & glass)	Aluminum/wood frame		n.a.	Н 3	n.a.	0,90	0,9
Average U-value of glazings	-	W/m²K	2,90		0,00	-	0,53-0
Average g-value of glazings	-	- h <sup>-1</sup>	n.a.	non	0,50		n.a
Ventilation Flow Rate	126 m <sup>3</sup> /h per apartment		0,70	0,50	0,3-0,6	0,30	0,3
Thermal Bridges	150 mm extra insulation	ayer in the e	external co	numns			
Air tightness & n50 air change rate							
Ventilation system type					kitchen and ba		
Energy saving measures	Waste wate 🛛 🔰				iovation/anartr	ments	
		neat recover	y, insulatio	on, root ren			
Water saving measures	Taps	ieat recover	y, insulatio	on, root ren	lovation/aparti		
Water saving measures Special building materials	Taps Roof apartments			on, root ren			
Water saving measures Special building materials	Taps			on, root ren	lovation, apara		
Water saving measures Special building materials Type of Shading	Taps Roof apartments	ding (balcor	nies)				
Water saving measures Special building materials Type of Shading Energy Systems	Taps Roof apartments Partial external solar sha		nies)				
Water saving measures Special building materials Type of Shading Energy Systems District Heating connection	Taps Roof apartments Partial external solar sha	ding (balcor	nies)				
Water saving measures Special building materials Type of Shading Energy Systems District Heating connection Photovoltaic - grid connected	Taps Roof apartments Partial external solar sha yes yes	ding (balcor Other inf	nies)				
Water saving measures Special building materials Type of Shading Energy Systems District Heating connection Photovoltaic - grid connected Solar thermal - flat plate	Taps Roof apartments Partial external solar sha yes yes no	ding (balcor	nies)				
Water saving measures Special building materials Type of Shading Energy Systems District Heating connection Photovoltaic - grid connected Solar thermal - flat plate Heat pump demo for waste water	Taps Roof apartments Partial external solar sha yes no yes	ding (balcor Other inf	nies)				
Water saving measures Special building materials Type of Shading Energy Systems District Heating connection Photovoltaic - grid connected Solar thermal - flat plate Heat pump demo for waste water Boiler	Taps Roof apartments Partial external solar sha yes yes no	ding (balcor Other inf	nies)				
Water saving measures Special building materials Type of Shading Energy Systems District Heating connection Photovoltaic - grid connected Solar thermal - flat plate Heat pump demo for waste water	Taps Roof apartments Partial external solar sha yes no yes	ding (balcor Other inf	nies)				
Water saving measures Special building materials Type of Shading Energy Systems District Heating connection Photovoltaic - grid connected Solar thermal - flat plate Heat pump demo for waste water	Taps Roof apartments Partial external solar sha yes no yes	ding (balcor Other inf	nies)				
Water saving measures Special building materials Type of Shading Energy Systems District Heating connection Photovoltaic - grid connected Solar thermal - flat plate Heat pump demo for waste water	Taps Roof apartments Partial external solar sha yes no yes	ding (balcor Other inf	nies)				ma 2
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Ringgården afdeling 21 (BEST-DK-1)

*Figure 42:* Guide to understanding the monitoring fact sheets for one selected RDS (DK1). See explanation of numbering in list above.

https://cowi.sharepoint.com/sites/A064318-project/Shared Documents/03 Deliverables/04 Reporting/07 WP7/D.7.3/04 Final Documents/D7.3 Evaluation of the operational monitoring data of the demonstration projects\_v2.4 final.docx

# 3.6 Other calculation prerequisites

#### 3.6.1 PV systems and photovoltaic part of PVT systems

PV efficiency is calculated on a monthly basis as metered PV output at the AC side of inverter per  $m^2$  PV(T) array, divided by global solar radiation per  $m^2$  on horizontal level:

 $PV system efficiency = \frac{PV \ electricity \ produced, kWh}{Global \ radiation \ x \ F_{area}, kWh}$ 

where: Farea is a factor of efficient PV area (approximately 0.9)

It is an overall <u>system efficiency</u> for the actual installation so therefore no correction is made for shade, orientation or tilt (tilt is with a few exceptions very low i.e. 10-20 deg.)

Normalisation to a standard year is made on a monthly basis by multiplying the heat produced with a normalization factor

Normalisation factor = 
$$\frac{\text{Standard global radiation}\frac{kWh}{m_2}\text{month}}{\text{Actual global insolation}\frac{kWh}{m_2}\text{month}}$$

#### 3.6.2 PVT systems – thermal part

The thermal output of PVT systems is monitored as heat to storage per m<sup>2</sup> collector area vs global solar radiation per m<sup>2</sup> horizontal:

 $Thermal \ system \ efficiency = \frac{Solar \ heat \ produced, kWh}{Global \ radiation \ x \ F_{area}, kWh}$ 

where: Farea is a factor of efficient panel area (approximately 0.9)

It is an overall <u>system efficiency</u> for the actual installation so therefore no correction is made for shade, orientation or tilt. Power for circulation pump is minor and therefore not monitored separately.

Normalisation to a standard year is made on a monthly basis by multiplying the heat produced with a normalization factor

 $Normalisation factor = \frac{Standard global radiation \frac{kWh}{m2}month}{Actual global insolation \frac{kWh}{m2}month}$ 

```
Energy performance targets from
4
     Building Energy Specification Table
```

In the Building Energy Performance Table (BEST) from the DOW all prerequisites, requirements and performance targets concerning building refurbishment and on-site RE production at the READY Demonstration Sites (RDS) and regarding the renewable energy supply to the RDS were defined. The content and structure of the BEST are exemplarily shown for RDS DK2 in Trigeparken below. The complete BEST of the RDS in Växjö and Aarhus are included in Annex B.

Local climate conditions in Aarhus as stated in the BEST (RDS DK2)

Local climate In the first BEST section, the prerequisites of the local climate are presented (see Table 11).

Table 11:

Local Climate		January average outside temperature	°C	0	
		August average outside temperature	°C	16	
Climatic Zone			kWh/m <sup>2</sup> yr	1000	
(national definition)	Denmark DK	Annual heating degree days [3]	°Cd/yr	2700	
		Room temperature	°C	20	

**Building Quality** In the second BEST section, the regulatory requirements, the actual values prior to building refurbishment and the suggested specification concerning the building envelope's properties (e.g. U-values) are presented (see Table 12).

> Table 12: Properties of building envelope for RDS DK2 prior to refurbishment, regulatory requirements and suggested specification for the building refurbishment

Maximum require	ments o	f building fabric	Existing building [5]	National regulation for new built [6]	suggested specification [7] *)	Energy savings [%] [8]
Facade/wall	U	W / m2K	0,7	0,3	0,17	75,7
Roof	U	W / m2K	0,5	0,2	0,12	76,0
Ground floor	U	W / m2K	0,75	0,2	0,3	60,0
Glazing	Ug	W / m2K	2,9	1,4	0,8	72,4
Average U-value	U <sub>av</sub>	W / m2K excl windows & doors	n.a.	0,22	0,22	n.a.
Glazing	<b>.</b>		n.a.	none	0,5	n.a.
Shading	nading Fs Shading correction factor		n.a.	none	external	n.a.
Ventilation rate [4]			0,7	126 m3/dwel	0,3-0,6	n.a.
		*) will depend on optimisation analysis				

Energy consumption

The BEST also includes the target values for the energy consumption of the buildings (see Table 13). The energy consumption is stated for the categories space heating, cooling, ventilation, lighting, hot water and electricity consumption for building operation (BOPS). The table includes the energy performance prior to building refurbishment, the regulatory requirements according to national regulations and the suggested specification.

The total energy performance target excl. appliances of the buildings is 78 kWh/m<sup>2</sup> excluding electricity for households.

Table 13:

Building energy performance of RDS DK2 before (Existing building) and after (suggested specification = BEST Target) building refurbishment as well as regulatory requirement and relative energy savings; given for each energy consumption category

energy carrier existing building	suggested energy carrier		specify energy efficiency measures [13]	Existing building [5]	National regulation / normal practice for new built (2006) [6]*	suggested specification [7]	% Energy savings [8]
Heating + ven	tilation						
District Heating	Low temp water	kWh/m <sup>2</sup> yr	Insulation, windows, tightness, accummulation	121	66	39	67,8
Cooling + ven	tilation						
Compressor	Water & air	kWh/m²yr	Sunshading	0	0	0	#DIV/0!
Ventilation (if	separate from heatin	g/cooling)					
Electricity	Air	kWh/m²yr	Intelligent demand controlled, energy eff fans	14	7	7	50,0
Lighting							
	Electricity PV	kWh/m²yr	Daylight access + LED + controls	12	6	4	66,7
Domestic Hot	Water (DHW)		*) Figure includes common lighting only			*)	
District Heating	Waste water HP	kWh/m²yr	Taps, Heat recovery, Smart grid control, reduced circ, loss	34	28	20	41,2
Other energy	demand						
Electricity	PV & Thermal solar	kWh/m²yr	Freq. contrl, red. idle load, a++ lenergy labels meters	13	9	8	38,5
		<mark>kWh/m<sup>2</sup>yr</mark>	Subtotal sum of energy demand	194	116	78	59,8

RE production/supply The buildings' energy consumption is covered by the supply from district heating and the electricity grid as well as by on-site produced energy from RES such as PV(T) and WW-HR systems. The contribution from the renewable share in district heating and electricity supply is stated as well (see Table 14).

total production		kW		Existing	National regulation /	Suggested specification	RES contribution	
kWh/yr	m <sup>2</sup> installed	installed	specify RES measures	building [5]	normal practice	[7]	[%][8]	
121500	810	109	PV partly building integrated	0	0	6	8,0	
216000	720	288	Solar thermal integrated with DH	0	0	11	14,3	
734614		n.a.	85% RES in waste heat from DH	0	0	38	48,5	
19468		n.a.	Waste water heat pump on selected blocks	0	0	4	4,5	
375000		300	Possible share in common wind turbine	0	0	19	24,7	
		kWh/m <sup>2</sup> yr	Subtotal sum of RES contribution	0	0	78	100	

Table 14:Absolute and relative contribution from RE at the RDS DK2 in kWh/m²yrresp. % (suggested specification = BEST Target)

# 5 Monitoring Results

The monitoring objective was to prove that the BEST Target Values concerning the Final Energy consumption (see Appendix B) were reached. In this chapter, the monitoring results are presented and compared to the BEST Target Values, where applicable. Monitoring results from other READY Demonstration Sites without READY Reference/Target values are presented without comparing to a baseline.

#### 5.1 Monitoring period

For new buildings as well as for refurbished buildings it takes approx. one or two years for the energy consumption to stabilise. There are several reasons for this, and one is that the building (if it is a residential building) typically is not 100% occupied from the beginning and therefore the first periods energy consumption can be misleading. Another reason is that the new installations require a period of running in and optimisation of controls and operation. The energy consumption will also include energy for drying out of the building, which is very energy demanding in a concrete building. In order to have the most accurate monitoring data, representative data should be available for at least one year.

Therefore, data from the last complete calendar year of READY project duration (i.e. 2019) was analysed, whenever possible. The building refurbishment of the buildings at the READY Demonstration Sites in Växjö was finished at the latest in 2018. Therefore, steady state monitoring data were broadly available. The building refurbishment of the buildings at some READY Demonstration Sites in Aarhus were finished in 2019-2020. This applies to some RES facilities in both, Växjö and Aarhus too.

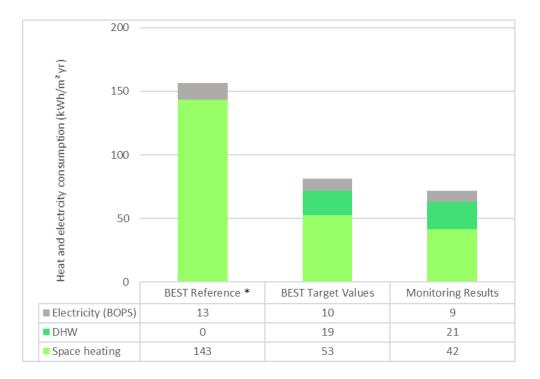
Missing, implausible or non-representative measurement data of affected months were replaced by reliable data from months with similar consumption/production conditions, eventually considering further input values (e.g. DRY heating degree days or global radiation data).

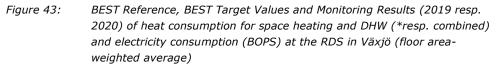
# 5.2 Final Energy consumption of buildings

At the READY Demonstration Sites in Växjö, the monitored normalised Final Energy consumption (heat consumption from heat and electricity consumption (BOPS)) in 2019 resp. 2020 was between 52.4 kWh/m<sup>2</sup>yr (RDS SE1.1) and 76.7 kWh/m<sup>2</sup>yr (RDS SE1). All values are floor area-weighted average values.

Figure 43 compares the measured normalised Final Energy consumption of all RDS in Växjö with the BEST Reference (see column "existing building" in BEST) and the BEST Target (see column "suggested specification" in BEST). All values are floor area-weighted average values.

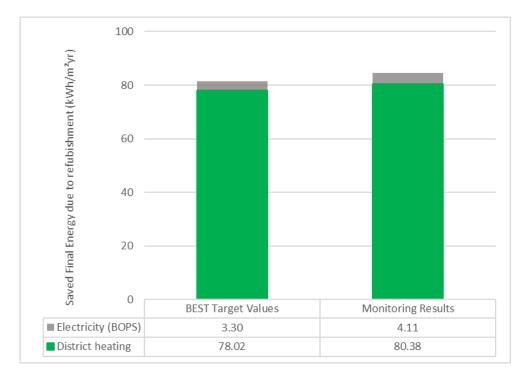
Växjö

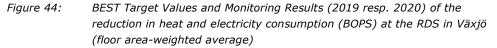




Compared to the baseline, the BEST Reference, these monitoring results correspond to a reduction in Final Energy consumption between 52% (RDS SE1) and 67% (RDS SE1.1). The floor area-weighted average reduction in Final Energy of all buildings at the READY Demonstration Sites in Växjö was 54%.

Figure 44 shows that the average reduction in Final Energy consumption at the RDS in Växjö exceeds the BEST Target. All values are floor area-weighted average values.



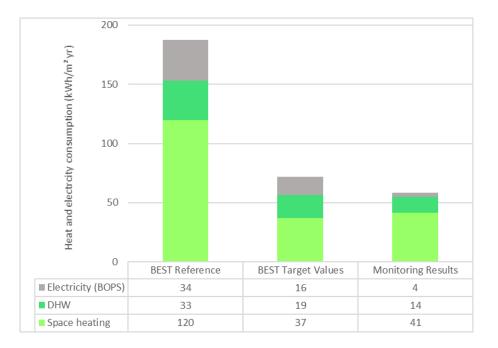


At the RDS in Aarhus, the monitored normalised Final Energy consumption in 2019 resp. 2020 was between 50.6 kWh/m<sup>2</sup>yr (RDS DK2) and 76.7 kWh/m<sup>2</sup>yr (RDS DK4).

Aarhus

Figure 45 compares the measured normalised Final Energy consumption of all RDS in Aarhus with the BEST Reference and the BEST Target. All values are floor area-weighted average values.

Compared to the baseline, the BEST Reference, these monitoring results correspond to a reduction in Final Energy consumption between 60% (RDS DK4) and 72% (RDS DK2). The floor area-weighted average reduction in Final Energy of all buildings at the RDS in Aarhus was 69%.



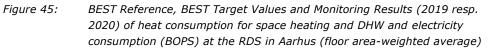
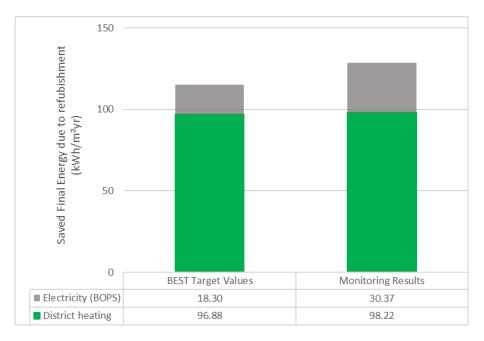


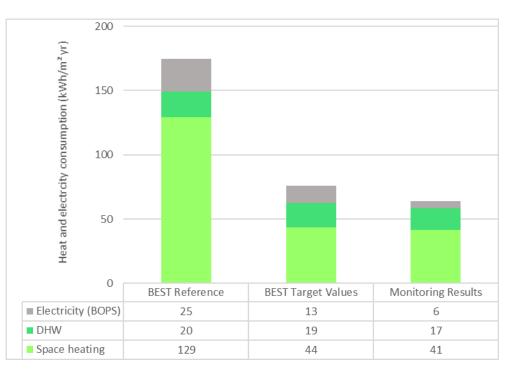
Figure 46 shows that the average reduction in Final Energy consumption at the RDS in Aarhus exceeds the BEST Target (see column "suggested specification" in BEST). All values are floor area-weighted average values.



*Figure 46:* BEST Target Values and Monitoring Results (2019 resp. 2020) of the reduction in heat and electricity consumption (BOPS) at the RDS in Aarhus (floor area-weighted average)

READY total In 2019 resp. 2020, the monitored normalised Final Energy consumption of the buildings at all RDS was 64.1 kWh/m<sup>2</sup>yr (floor area-weighted average).

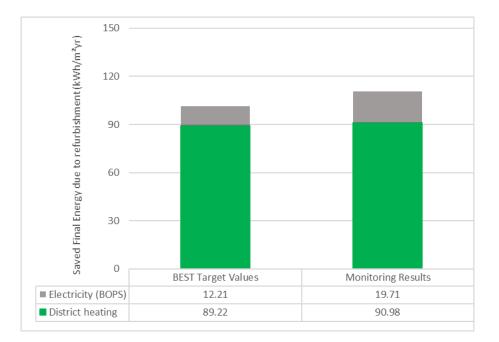
Figure 47 compares the measured normalised Final Energy consumption of all RDS with the BEST Reference and the BEST Target. All values are floor area-weighted average values.





Compared to the baseline, the BEST Reference, these monitoring results correspond to a reduction in Final Energy consumption of 63%.

Figure 46 shows that the average reduction in Final Energy consumption at the RDS exceeds the BEST Target (see column "suggested specification" in BEST). All values are floor area-weighted average values.



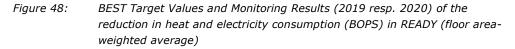


Table 15 shows the heat consumption from district heating, the electricity consumption (BOPS) and the resulting Final Energy consumption as well as the reduction in heat, electricity (BOPS) and the resulting total Final Energy consumption of all buildings in READY. The electricity consumption (BOPS) at RDS SE1.1 is higher than at the other RDS as the electricity consumption of heat pumps in PVT and WW-HR systems has been included in this category.

Code	Final Energy consumption	Heat consumption	Electricity consumption (BOPS)	Reduction in Final Energy consumption	Reduction in heat consumption	Reduction in electricity consumption (BOPS)	Rel. reduction in Final Energy consumption
	kWh/m²yr	kWh/m²yr	kWh/m²yr	kWh/m²yr	kWh/m²yr	kWh/m²yr	%
SE1	76.7	68.2	8.5	83.3	80.8	2.5	52
SE1.1	52.4	37.1	15.3	107.6	111.9	-4.3	67
SE3	52.9	47.8	5.2	71.1	45.2	25.8	57
DK1	64.2	60.9	3.3	129.8	94.1	35.7	67
DK2	50.6	47.4	3.2	130.4	107.6	22.8	72
DK3	57.8	43.1	14.7	81.2	52.9	28.3	58
DK4	76.7	51.9	3.2	117.3	103.1	35.8	60
Sum SE	71.9	63.0	8.9	84.5	80.4	4.1	54
Sum DK	58.7	55.0	3.6	128.6	98.2	30.5	69
Total	64.1	58.3	5.7	110.7	91.0	19.8	63

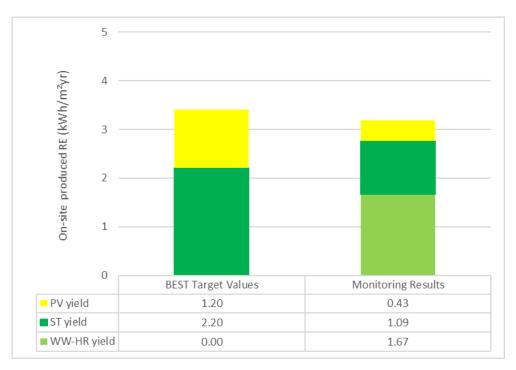
Table 15:Normalised (reduction in) Final Energy, heat and electricity consumption<br/>(BOPS) in READY

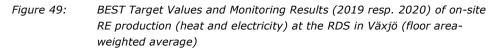
#### 5.3 RE production at READY Demonstration Sites

At the READY Demonstration Sites in Växjö, the monitored normalised on-site RE production<sup>37</sup> in 2019 resp. 2020 was 2.8 kWh/m<sup>2</sup>yr regarding heat and 0.4 kWh/m<sup>2</sup>yr regarding electricity. The total on-site RE production in Växjö was 3.2 kWh/m<sup>2</sup>yr. All values are floor area-weighted average values.

Figure 49 shows the BEST Target Values and Monitoring Results (2019 resp. 2020) of the floor area-weighted average heat (ST yield) and electricity (PV yield) production from roof-top Photovoltaic (PV) and Photovoltaic Thermal (PVT) systems as well as from WW-HR facilities (WW-HR yield) at the RDS in Växjö.

The actual on-site RE production does not meet the target according to the BEST. This is due to changes in the planning of facilities for on-site RE production during the project duration.





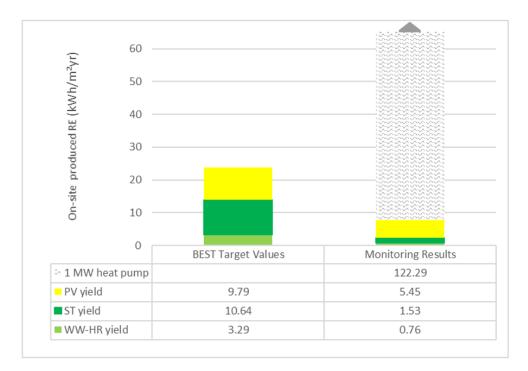
Växjö

<sup>&</sup>lt;sup>37</sup> Due to delays in construction and commissioning as well as difficulties in the first months of operation at some RES facilities, missing, implausible or non-representative measurement values were replaced by values calculated from reliable measurement values from other months and further input values (e.g. global radiation).

Aarhus

At the READY Demonstration Sites in Aarhus, the monitored normalised on-site RE production in 2019 resp. 2020 was 2.3 kWh/m<sup>2</sup>yr regarding heat and 5.5 kWh/m<sup>2</sup>yr regarding electricity. The total on-site RE production in Aarhus was 7.8 kWh/m<sup>2</sup>yr. All values are floor area-weighted average values.

Figure 50 shows the BEST Target Values and Monitoring Results (2019 resp. 2020) of the floor area-weighted average heat (ST yield) and electricity (PV yield) production from roof-top Photovoltaic (PV) and Photovoltaic Thermal (PVT) systems as well as from WW-HR facilities (WW-HR yield) at the RDS in Aarhus. Due to deviations from the original plans for the installation of RES facilities, the on-site RE production of heat and electricity does not meet the target. But this is more than overcompensated by a 1 MW heat pump (see 5.4) in Aarhus harbour which had not been planned originally. The heat pump's contribution is indicated as it does not belong to this category and as its corresponding bar height does not fit into the graph's y axis scale (indicated with the grey arrow). This applies to all graphs where the contribution of the 1 MW heat pump is indicated. The HP electricity consumption is not included in the graph.

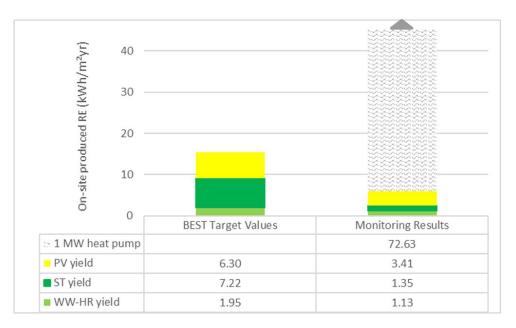


*Figure 50:* BEST Target Values and Monitoring Results (2019 resp. 2020) of on-site RE production (heat and electricity) at the RDS in Aarhus (floor areaweighted average). The contribution from the 1 MW heat pump is indicated.

READY total In 2019 resp. 2020, the normalised on-site RE production (heat and electricity), as monitored in READY, was 2.5 kWh/m<sup>2</sup>yr resp. 3.4 kWh/m<sup>2</sup>yr. The total onsite RE production in READY was 5.9 kWh/m<sup>2</sup>yr.

Figure 51 shows the BEST Target Values and Monitoring Results (2019 resp. 2020) of the floor area-weighted average heat (ST yield) and electricity (PV yield) production from all roof-top Photovoltaic (PV) and Photovoltaic Thermal

(PVT) systems as well as from all WW-HR facilities (WW-HR yield) in READY. The above mentioned 1 MW heat pump, whose contribution is also indicated in this graph, can compensate not only the shortcomings regarding the RE production at the RDS in Aarhus, but also in a project wide view. In Figure 51, the heat pump's bar height does not fit into the graph's y axis scale neither. The on-site heat, electricity and resulting total RE production at each READY Demonstration Site is listed in Table 16.



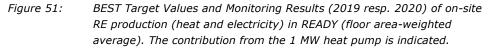


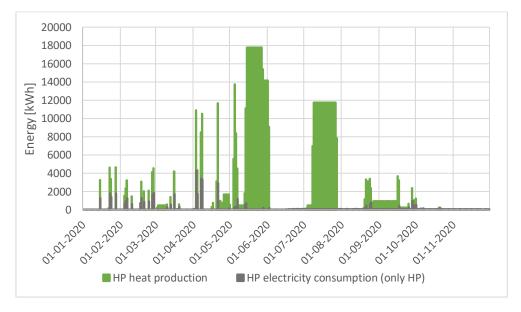
Table 16:Monitored on-site RE production (heat and electricity) at the RDS in<br/>absolute numbers. Cells with calculated numbers due to missing<br/>monitoring data are highlighted in grey

Code	PV	(T)	WW-HR	Total RE production	
	Electricity yield	Heat yield	Heat yield	Heat	Electricity
	kWh/yr	kWh/yr	kWh/yr	kWh/yr	kWh/yr
SE1					
SE1.1	14,329	36,644	55,964	92,608	14,329
SE3					
DK1	144,449		7,462	7,462	144,449
DK2	95,693	75,221	29,847	105,068	95,693
DK3	27,366				27,366
DK4					
Sum SE	14,329	36,644	55,964	92,608	14,329
Sum DK	267,509	75,221	37,309	112,530	267,509
Total	281,838	111,865	93,273	205,138	281,838

#### 5.4 Heat production and electricity consumption by 1 MW sea water-fed heat pump

The 1 MW sea water-fed heat pump at Aarhus harbour (RDP DK-WW1) has been monitored since January 2020. The heat pump's performance of the first 11 month of operation is shown in Figure 52. The graph shows a normal operation only in May. During the first months of operation, technical issues that are normal in initial operation phases of large heat pump systems lead to limited operating conditions.

As the heat pump is still in experimental operation mode, standard operation conditions could not be investigated for longer periods of time. Nevertheless, under standard operating conditions, the heat pump is expected to provide an annual heat generation of approx. 6 GWh (assuming 6.000 full load hours per year). As no better data are available, this reference value serves as representative "monitoring result" for the analyses in WP7.



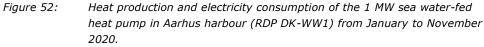
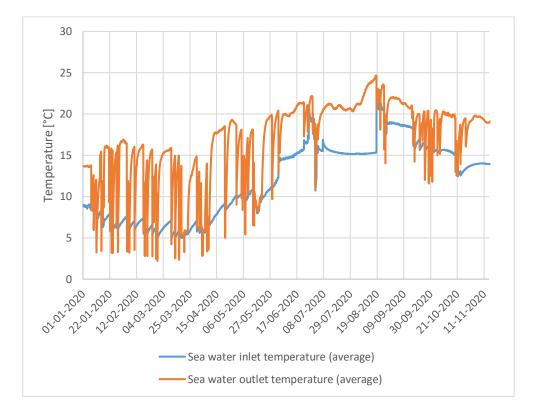


Figure 53 shows the inlet and outlet temperatures of the 1 MW sea water-fed heat pump. This graph shows consistency with the energy production values in Figure 52 as the outlet temperature falls below the inlet temperature only during the few, mainly short operation periods.



*Figure 53:* Seawater inlet and outlet temperatures of the 1 MW sea water-fed heat pump in Aarhus harbour (RDP DK-WW1), from January to November 2020

Table 17 shows the heat pump's heat and electricity production as well as the resulting COPs. The table only contains the values of the months January to April as later measurements were not reliable. The COP varies from 2.1 in January to 3.6 in April. As expected, the COP is affected by the water temperature, where a higher temperature ensures a better performance of the heat pump. As it is shown in Figure 52 and Figure 53, the heat pump had many starts and stops during this initial period of operation, which negatively affect the COP. The COP is expected to be higher when the system operates continuously. The monitoring is being continued until standard operating conditions are achieved and the heat pump's expected efficiency can be confirmed.

Month	Heat Production (kWh)	Electricity consumption (only HP) (kWh)	СОР
January 2020	16,140	7,695	2.1
February 2020	24,610	11,334	2.2
March 2020	10,450	4,328	2.4
April 2020	61,900	16,996	3.6

 
 Table 17:
 Monitored performance of the seawater heat pump and calculated COP (January to April 2020)

Table 18 presents a further evaluation of the heat pump's performance considering the primary energy (PE) factors for electricity and district heating, which were respectively **2.1 and 1.0**, following the inputs from the Directive (EU) 2019/2002. It is therefore possible to evaluate the primary energy input and output for the seawater heat pump and the related COP factor for the

monitored months. In relation to the primary energy balance, the use of a heat pump can lead to a reduction in primary energy consumption, when the COP is higher than 2.1.

Month	Heat Production (kWh)	PE consumption of HP (kWh)	COP <sub>PE</sub> '
January 2020	16,140	16,160	1.0
February 2020	24,610	23,801	1.0
March 2020	10,450	9,089	1.1
April 2020	61,900	35,692	1.7

Table 18:Performance of the seawater heat pump considering the primary energy<br/>factors (January to April 2020)

5.5 Renewable heat and electricity supply to the READY Demonstration Sites

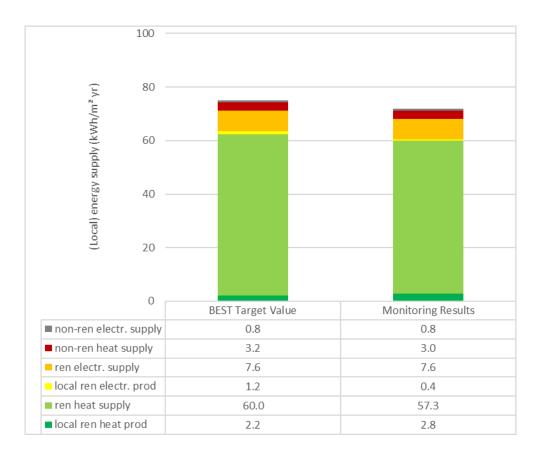
The READY Demonstration Sites are supplied by renewable heat and electricity from on-site RES facilities as well as from the local district heating and electricity networks. The share of renewable heat and electricity supply via the local district heating networks and the electricity grids was determined regarding the networks' corresponding energy mix. In Aarhus resp. Växjö the renewable share in district heating is 80% resp. 95%. The renewable share in electricity production is 66%<sup>38</sup> resp. 90%<sup>39</sup>.

Växjö

Figure 54 shows the BEST Target Values and Monitoring Results (2019 resp. 2020) of the energy supply to the RDS in Växjö as floor area-weighted average values. To show the complete picture, the non-renewable energy supply is also included in the graphs. Consequently, the total heights of the bars correspond to the buildings' Final Energy consumption of heat and electricity (see Figure 43). The supply's highly renewable energy mix leads to a very small non-renewable share of 3 kWh/m<sup>2</sup>yr. This value is even slightly better than the BEST Target Value, although the actual energy production at RES facilities does not meet the target. The buildings' heat and electricity consumption (BOPS) is significantly below the BEST Target Values, which compensates the reduced RE production.

<sup>&</sup>lt;sup>38</sup> See <u>https://en.wikipedia.org/wiki/Electricity sector in Denmark</u> (as of 2017)

<sup>&</sup>lt;sup>39</sup> See <u>https://www.energimyndigheten.se/nyhetsarkiv/2020/2019-rekordar-for-svensk-elproduktion/</u> (as of 2019)



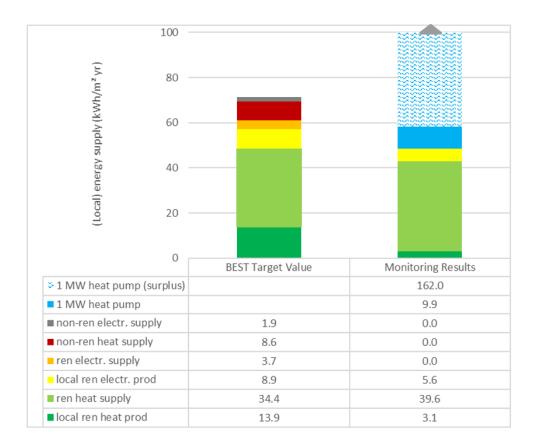
*Figure 54:* BEST Target Values and Monitoring Results (2019 resp. 2020) of the total renewable and non-renewable energy supply to the buildings and the onsite RE production in Växjö (floor area-weighted average).

AarhusFigure 55 shows the BEST Target Values and Monitoring Results (2019 resp.2020) of the energy supply to the buildings and the on-site RE production in<br/>Aarhus as floor area-weighted average values.

Due to the contribution of the 1 MW heat pump in Aarhus harbour, there is no non-renewable share in the heat supply at all, but just the opposite: the heat pump could supply the heat for the RDS in Aarhus several times.

As its corresponding bar height does not fit into the graph's y axis scale, the heat pump's contribution is indicated. The HP electricity consumption is not included in the graph.

Over the course of one year, the electricity consumption (BOPS) at the RDS in Aarhus is completely covered by the on-site PV yield, so that there is neither renewable, nor non-renewable electricity <u>supply</u> in the Monitoring Results bar.

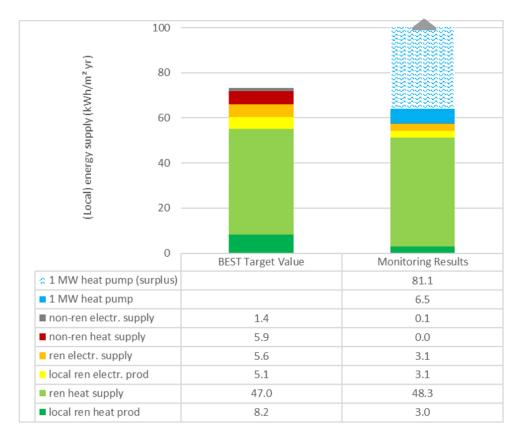


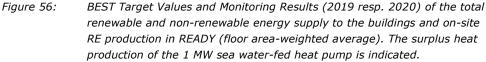
*Figure 55:* BEST Target Values and Monitoring Results (2019 resp. 2020) of the total renewable and non-renewable energy supply to the buildings and the onsite RE production in Aarhus (floor area-weighted average). The surplus heat production of the 1 MW sea water-fed heat pump is indicated.

#### READY total Figure 56 shows the BEST Target Values and Monitoring Results (2019 resp. 2020) of the energy supply to all READY Demonstration Sites as floor areaweighted average values.

Due to the contribution of the 1 MW heat pump in Aarhus harbour, there is no non-renewable share in the heat supply at all, but just the opposite: the heat pump could supply the heat for all READY Demonstration Sites twice.

As its corresponding bar height does not fit into the graph's y axis scale, the heat pump's contribution is indicated. The HP electricity consumption is not included in the graph.

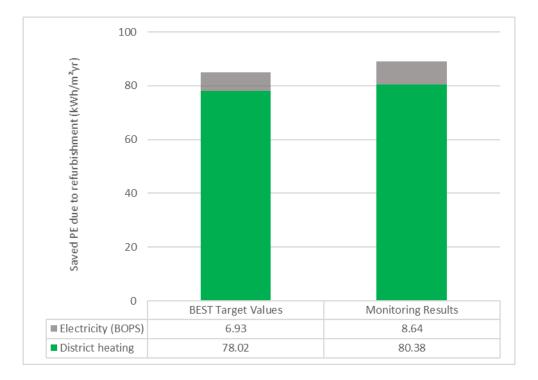


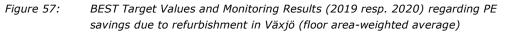


# 5.6 Primary Energy savings at READY Demonstration Sites

The evaluation of the Primary Energy (PE) savings due to refurbishment and onsite RE production was performed considering PE factors for electricity (2.1) and district heating (1.0), following the inputs from the Directive (EU) 2019/2002.

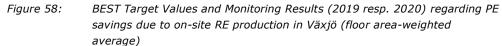
Växjö The Final Energy savings due to refurbishment at the RDS in Växjö lead to PE savings of 80.4 kWh/m<sup>2</sup>yr regarding heat and 8.6 kWh/m<sup>2</sup>yr regarding electricity. Figure 57 shows the BEST Target Values and Monitoring Results (2019 resp. 2020) of the floor area-weighted average PE savings regarding heat and electricity consumption (BOPS) at the RDS in Växjö.





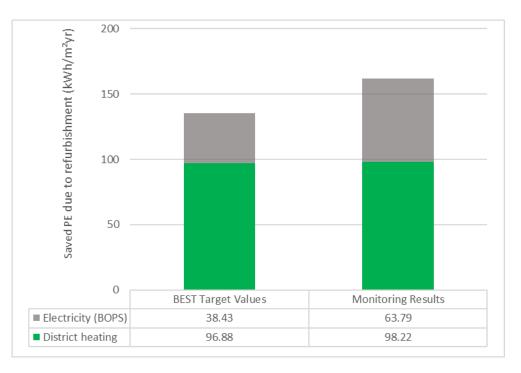
The Final Energy savings due to on-site RE production lead to PE savings of 2.8 kWh/m<sup>2</sup>yr regarding heat and 0.9 kWh/m<sup>2</sup>yr regarding electricity. Figure 58 shows the BEST Target Values and Monitoring Results (2019 resp. 2020) of the floor area-weighted average PE savings due to on-site RE production (heat and electricity) in Växjö.

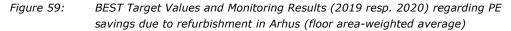




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Aarhus The Final Energy savings due to refurbishment at the READY Demonstration Sites in Aarhus lead to PE savings of 98.2 kWh/m<sup>2</sup>yr regarding heat and 63.8 kWh/m<sup>2</sup>yr regarding electricity. Figure 57 shows the BEST Target Values and Monitoring Results (2019 resp. 2020) of the floor area-weighted average PE savings regarding heat and electricity consumption (BOPS) at the RDS in Aarhus.

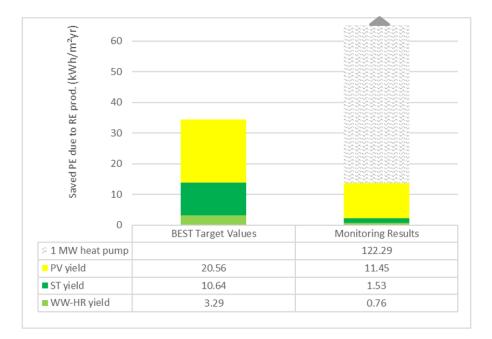


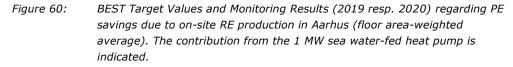


The Final Energy savings due to on-site RE production lead to PE savings of 2.3 kWh/m<sup>2</sup>yr regarding heat and 11.5 kWh/m<sup>2</sup>yr regarding electricity.

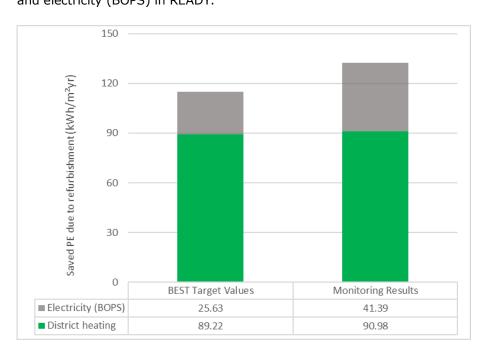
Figure 58 shows the BEST Target Values and Monitoring Results (2019 resp. 2020) of the floor area-weighted average PE savings due to on-site RE production at the RDS in Aarhus.

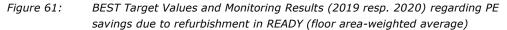
As a consequence of the deviations between planned and actually installed RES capacities (see 5.3), the BEST Target regarding saved PE due to on-site RE production is not met either but this shortcoming is also compensated by the contribution of the 1 MW heat pump (indicated in the graph, HP electricity consumption not shown).





READY total In READY, the Final Energy savings due to building refurbishment lead to PE savings of 91.0 kWh/m<sup>2</sup>yr regarding heat and 41.4 kWh/m<sup>2</sup>yr regarding electricity. Figure 57 shows the BEST Target Values and Monitoring Results (2019 resp. 2020) of the floor area-weighted average PE savings regarding heat and electricity (BOPS) in READY.



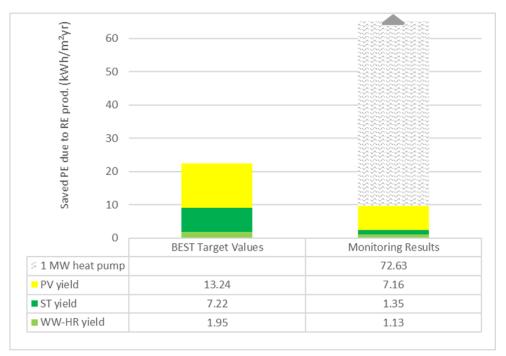


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The Final Energy savings due to on-site RE production lead to PE savings of 2.5 kWh/m<sup>2</sup>yr regarding heat and 7.2 kWh/m<sup>2</sup>yr regarding electricity.

Figure 58 shows the BEST Target Values and Monitoring Results (2019 resp. 2020) of the floor area-weighted average PE savings due to on-site RE production in READY.

The graph shows that the 1 MW heat pump, whose contribution is also indicated in this graph (electricity consumption not included), can compensate not only the shortcomings regarding the on-site RE production in Aarhus, but also in a project wide view. In Figure 58, the heat pump's bar height does not fit into the graph's y axis scale neither.



*Figure 62:* BEST Target Values and Monitoring Results (2019 resp. 2020) regarding PE savings due to on-site RE production in READY (floor area-weighted average). The contribution from the 1 MW sea water-fed heat pump is indicated.

### 5.7 Performance of Battery Energy Storage System

The performance of the Battery Energy Storage System (BESS, RDP DK-ST) in Trigeparken (RDP DK2) was examined for the two representative operating conditions

- 1. High PV yield (PVH)
- 2. Low PV yield (PVL)

The performance of the BESS at PVH operating conditions is shown in Figure 63. The graph shows the PV production (yellow line), the battery state of charge (green line) between 0% (corresponds to the y axis label "-90 kW") and 100% ("90 kW"), the buildings' electricity consumption (blue line) and the power at the

billing point of the building (black line) from the evening of June  $23^{rd}$  to the evening of June  $25^{th}$ .

The PV production starts on June 24<sup>th</sup> after sun rise. When the PV production exceeds the building's consumed power at (1), the BESS starts to capture the surplus electricity production from the PV system. Then, grid supply is zero or negative. The latter happens, when PV production exceeds the total of the building's power consumption and the BESS' max. charging power. On a sunny day like this, the battery gets fully charged after a few hours of PV production at (2). In the evening, the PV production falls below the building's power consumption, hence, the BESS starts to supply power to the building in order to substitute the gap between production and consumption (3). Over the night, the BESS is discharged completely (state of charge = 0%) (4) but is being charged again with the excess PV production of the next day (June 25<sup>th</sup>).

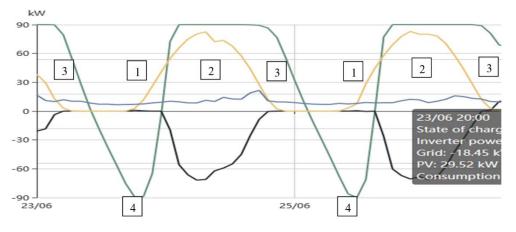


Figure 63: BESS performance at PVH operation condition (RDP DK-ST)<sup>40</sup>

The performance of the BESS during the night and morning after a day with low PV generation (PVL) is shown in Figure 64. Analogously to Figure 63, the graph shows the PV production, the battery state of charge, the buildings' electricity consumption and the power at the billing point of the building.

As the BESS must start to supply power to the building early in the day due to low PV production, the BESS is discharged completely already before midnight (1). Then, the buildings' electricity consumption must be fully covered by the grid, until the PV production starts again at the morning of the next day. Although the PV production (of the next day) is low, it exceeds the building's consumed power at some point and the surplus electricity production is captured as described above (PVH).

<sup>&</sup>lt;sup>40</sup> See D.5.5.1

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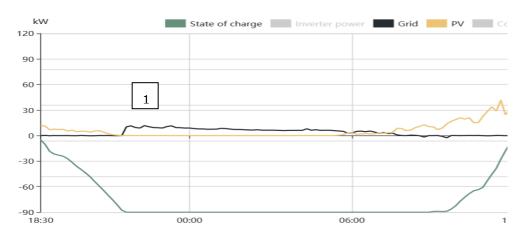
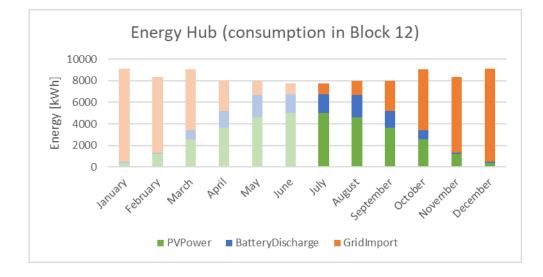
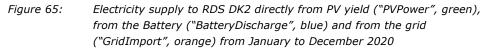


Figure 64: BESS performance at PVL operating condition (RDP DK-ST)

Figure 65 shows the electricity supply to the buildings at RDS DK2 from January to December 2020<sup>41</sup>. In winter, December and January in particular, the supply is almost completely provided by the grid, but in summer, almost the whole consumption can be covered with the PV yield. From May to September, approx. 20% more PV yield can be used due to the BESS, which is charged when PV production exceeds the consumption and discharged, when the PV production provides less power, than the buildings' electricity demand.





<sup>&</sup>lt;sup>41</sup> Reliable monitoring data was available for the period July to December. The data from January to June were obtained by mirroring the available data.

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# 5.8 Reduction in pipe heat losses in optimised district heating network

The pipe heat losses of the Low-temperature district heating network in Alabastern (RDP SE-DH) were determined by centrally measuring the total heat supplied to the district and by comparing this value to the sum of all heat metering values from the meters in the buildings. Compared to empirical pipe heat loss values in similar districts, the reduction in pipe heat losses is approx. 106 MWh per year, i.e. a reduction of 60% compared to pipe heat losses in conventional district heating networks (baseline: 12 % of DH supply). This reduction corresponds exactly to the planning value. The saved PE is equal to the saved heat. The Monitoring Results in 2020 and calculated heat reduction values are shown in Table 19.

Month	Supply	Consumption	Heat loss		Saved heat	
	kWh	kWh	kWh	%	%*	kWh
Jan	191,730	184,105	7,625	4.0	12	15,383
Feb	186,430	179,429	7,001	3.8	12	15,371
Mar	191,380	184,025	7,355	3.8	12	15,611
Apr	127,680	121,524	6,156	4.8	12	9,166
Мау	102,970	97,474	5,496	5.3	12	6,860
Jun	54,470	52,161	2,309	4.2	12	4,227
Jul	54,380	49,525	4,855	8.9	12	1,671
Aug	55,620	50,765	4,855	8.7	12	1,819
Sep	63,310	58,503	4,807	7.6	12	2,790
Oct	107,410	102,014	5,396	5.0	12	7,493
Nov	139,560	133,794	5,766	4.1	12	10,981
Dec <sup>42</sup>	190,864	182,978	7,886	4.1	12	15,018
Year	1,465,804	1,396,297	69,507	4.7	12	106,390

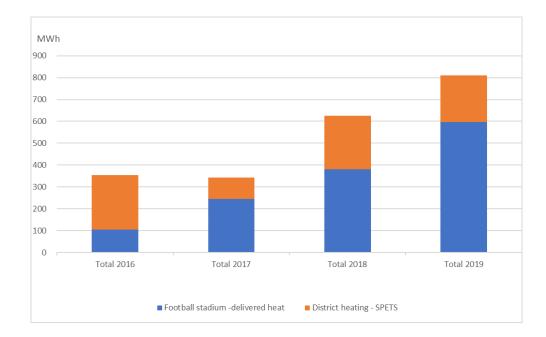
Table 19:District heating supply and end users' heat consumption in Alabastern<br/>(Växjö), derived pipe heat losses and saved heat in 2020 (\* baseline)

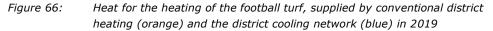
# 5.9 Energy savings in the innovative district cooling project "energy used three times"

The innovative district cooling project "energy used three times" in Växjö (RDP SE-WW1) achieved a reduction in cooling energy consumption by increasing the energy efficiency of a data centre's cooling system by 1 GWh per year. Additionally, by heating a football turf with waste heat from the district cooling network, 600 MWh of cooling energy and the same amount of heat from district heating can be saved per year (2019, see Figure 66).

<sup>&</sup>lt;sup>42</sup> No monitoring values available, supply value from 2019, relative losses from November 2020. Other values derived from those.

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Saved cooling energy As the cooling energy is provided by an absorption chiller (COP of 0.65), powered by heat from the district heating network, the total saved heat due to the reduction in cooling energy consumption was 2.5 GWh. Including the free cooling waste heat used for the football turf the total heat savings in 2019 were approx. 3.1 GWh. As the two cooling energy consumers (shopping centre and data centre) could be supplied by the same flow, energy consumption for pumping could be reduced as well (not part of monitoring). The monitored cooling energy and heat consumption values as well as the derived energy savings (both for 2019) are listed in Table 20.

Cooling energy consumption - data centre (MWh/yr)	1,292
Saved cooling energy at data centre (MWh/yr)	1,034
Heat consumption – football turf (MWh/yr)	811
Waste heat consumption – football turf (MWh/yr)	597
Total saved cooling energy (MWh/yr)	1,631
COP of absorption chiller (-)	0.65
Saved heat for absorption chiller (MWh/yr)	2,509
Total saved DH heat (MWh/yr)	3,106

Table 20:Monitored district cooling resp. heating supply to the data centre and the<br/>football turf as well as derived energy savings in 2019

### 5.10 Monitoring of EV charging stations

At the charging stations for electrical vehicles (EV) in Aarhus (DK-Ch), the annually supplied electricity and the usage of each charging sock were monitored. The annual electricity volume of all charging stations increased by approx. 100% every year, as shown in Table 21. The utilization rate of the charging stations, which has been on average 3%, is presented in Figure 67. The utilization rate is the total time of usage per day divided by 24 hours.

Table 21:Total annually supplied electricity of EV charging stations between 2015and 2019

Year	Consumption (kWh)
2015	17,289
2016	39,183
2017	78,440
2018	107,824
2019	186,858

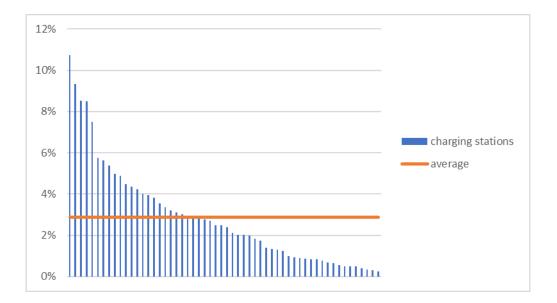


Figure 67:

Utilization rate of all charging stations of DK-Ch (average utilization rate of all charging stations, and per charging station, sorted from the maximum to the minimum value)

## 6 Environmental impact

#### 6.1 CO<sub>2</sub> emission factors

In order to determine the  $CO_2$  emission<sup>43</sup> savings due to READY energy saving/production measures,  $CO_2$  emission factors for heat and electricity are required. These values depend on the energy mix of the respective energy form. Different approaches to determine  $CO_2$  emission factors exist, but in READY only the following 2 approaches were applied:

#### Approach 1 "Planning values"

The CO<sub>2</sub> emission factors are derived from the energy mix of marginal heat/electricity production in the city/region where the measure is applied. Marginal heat/electricity production refers to energy production supply peaks. The used CO<sub>2</sub> emission factors were official planning values from 2012 used as basis for the READY project (DOW) and hence, used to calculate the expected CO<sub>2</sub> emission savings.

#### Approach 2 "Average values"

The  $CO_2$  emission factors are derived from the average energy mix of heat/electricity production in the specific country of the respective READY Demonstration Site.

The  $CO_2$  emission factors for heat from the district heating network and electricity from the grid of both approaches are presented in Table 22.

electricity from the grid u	ised in READY	
	Aarhus	Växjö
Approach 1 "Planning v	values" (main approad	ch in WP7)

Table 22:	CO <sub>2</sub> emission factors for heat from the district heating network and
	electricity from the grid used in READY

Approach 1 "Planning values" (main approach in WP7)					
CO <sub>2</sub> emission factor of marginal heat production according to DOW	108 g CO <sub>2</sub> /kWh	74 g CO₂/kWh			
CO <sub>2</sub> emission factor of marginal electricity production according to DOW	770 g CO₂/kWh	400 g CO <sub>2</sub> /kWh			
Approach 2 "Average values (2019)"					
CO <sub>2</sub> emission factor of heat production according to actual energy mix in Sweden resp. Denmark	33 g CO₂/kWh	0 g CO₂/kWh			
CO <sub>2</sub> emission factor of electricity production according to actual energy mix in Sweden resp. Denmark	130 g CO₂/kWh	125 g CO₂/kWh			

 $<sup>^{43}</sup>$  The term "CO<sub>2</sub> emissions" includes all climate relevant emissions which are considered as CO<sub>2</sub> equivalent emissions. In WP7, no further emissions than CO<sub>2</sub> emissions were

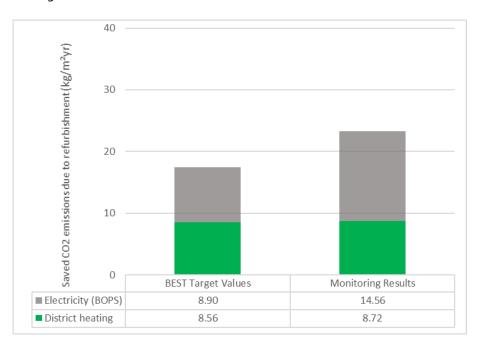
For the assessment of the expected ecological impact of the energy saving and RE production measures in READY, approach 1 was used for first assessments in the project's initial phase. In order to assess the target fulfilment, the same approach was applied to calculate the respective  $CO_2$  emission savings according to the Monitoring Results.

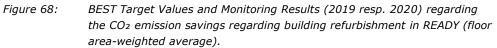
Alternatively, approach 2 was applied too, but as the heat and electricity production in Aarhus and Växjö is becoming more and more carbon-free, these values are close to zero and hence, for the analysis of READY's environmental impact not very meaningful. Therefore, the results of these calculations are not presented in this report.

#### 6.2 CO<sub>2</sub> emission savings

The extensive energy savings due to building refurbishment and on-site RE production achieved at the READY Demonstration Sites lead to significant CO<sub>2</sub> emission savings, which were derived from the Monitoring Results regarding Final Energy savings due to building refurbishment (see 5.2), regarding on-site RE production, the potential heat production of the 1 MW sea-water fed heat pump, the saved heat losses due to the optimisation of the district heating network and the heat savings achieved in the RDP "energy used three times". The monitoring data is from 2019 resp. 2020.

Building refurbishment The CO<sub>2</sub> emission savings due to the building refurbishment in 2019 resp. 2020 were approx. 255 tons (RDS in Växjö) resp. 1,668 tons (RDS in Aarhus) or 1,923 tons (total) per year. Figure 68 shows the environmental impact of the building refurbishment at all READY Demonstrations Sites as floor area-weighted average values.





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RE productionThe annual CO2 emission savings due to on-site RE production at READYDemonstration Sites in Växjö were approx. 6.9 tons regarding heat and 5.7<br/>tons regarding electricity.

The annual  $CO_2$  emission savings due to on-site RE production at RDS in **Aarhus** were approx. 12 tons regarding heat and 206 tons regarding electricity.

For the whole READY project, this sums up to total annual  $CO_2$  emission savings of approx. 19 tons regarding heat and 212 tons regarding renewable electricity production resp. 231 tons in total.

Additionally, the 1 MW sea water-fed heat pump in Aarhus harbour (Denmark) saves CO<sub>2</sub> emissions of approx. 648 tons per year.

Figure 69 shows the environmental impact of on-site RE production in READY. The 1 MW heat pump's impact is indicated. The  $CO_2$  emission savings in the improved district heating network in Växjö and the other measures, not mentioned in this paragraph, are not included.

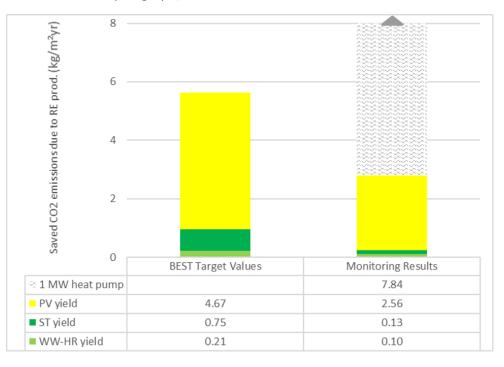


Figure 69: BEST Target Values and Monitoring Results (2019 resp. 2020) regarding the CO<sub>2</sub> emission savings due to on-site RE production in READY (floor area-weighted average). The contribution from the 1 MW sea water-fed heat pump is indicated. Further measures The improvement of the district heating network in Alabastern district (RDP SE-DH) saves approx. 106 MWh heat which results in CO<sub>2</sub> emission savings of 7.9 tons every year.

The saved heat of approx. 3.1 GWh by of the innovative district cooling project "energy used three times" in Växjö (RDP SE-WW1) lead to  $CO_2$  emission savings of approx. 230 tons per year (see 5.9).

READY total Summarising all calculation results regarding CO<sub>2</sub> emission savings, READY counts with an environmental impact of **2,320 tons** of avoided CO<sub>2</sub> emissions every year. Assuming an average lifespan of buildings and RE production facilities of 30 years, READY's total environmental impact would account to almost **70 thousand tons** of avoided CO<sub>2</sub> emissions.

These results are close to the results of the rough calculations performed during the project's initial phase. From the energy saving/RE production measures in READY, **3,689 tons** of yearly saved  $CO_2$  emissions were expected. Within the assumed 30 years lifespan, this would account to **110 thousand tons** of avoided  $CO_2$  emissions. These numbers are higher than the actual values, but it should be considered, that these values were calculated in a very early stage of the project.

The 30 years GHG emission saving target derived from the BEST Target Values regarding Final Energy savings/production (not all READY measures included) is 57 thousand tons, the corresponding actual savings are 62 thousand tons. Compared to the BEST Target, the READY project was successful in this regard as well.

### 7 Economic analysis

Energy savings and hence  $CO_2$  emission savings not only help to tackle the climate change but also lead to significant cost savings which are the basis for economic analyses regarding the cost effectiveness of energy saving measures. One common financial indicator used to evaluate the cost effectiveness of energy saving measures is the simple payback time (see 7.3), another important indicator is the cost of reducing greenhouse gas emissions.

# 7.1 Investment costs and O&M costs regarding building refurbishment

To determine the share of the investment costs for building refurbishment that was necessary to achieve the energy savings presented above, certain empirical factors had to be used. These allocation factors for the determination of the energy-related investment costs are presented in Table 23.

Table 23:	Allocation factors for the calculation of the energy-related investment
	costs, lifespan of the building components and RES facilities and relative
	O&M costs in READY

Component	Allocation factor	Lifespan	rel. O&M costs
	%	years	%
Windows	25	30	-
Building envelope	20	40	-
Ventilation	90	30	1

The basis for the determination of the energy-related investment costs are the actual investment costs for windows, the building envelope and the ventilation system.

Considering the component's lifespan, fictitious annual reinvestment costs were calculated. The total and the planned resp. actual energy-related investment costs as well as reinvestment costs and Operating and Maintenance (O&M) costs are listed for the READY Demonstration Sites in Table 24.

Baseline In READY, the expected energy-related share of investment costs for building refurbishment was 100 EUR/m<sup>2</sup>. Based on that value, the EC Support for building refurbishment was defined to 50% of the corresponding energy-related share of investment costs with an upper limit of 50 EUR/m<sup>2</sup>.

Actual situation In Växjö, the actual energy-related share of investment costs for building refurbishment turned out to be 244 EUR/m<sup>2</sup> while in Aarhus, the actual value was equal to the expected value of around 100 EUR/m<sup>2</sup>.

Consequently, the floor area-weighted average of all READY Demonstration Sites is 166 EUR/m<sup>2</sup> which is in absolute numbers 13 MEUR. As READY could count on

4 MEUR EC support for building refurbishment, 9 MEUR had to be covered by the READY project partners.

The total cost of refurbishment is significantly higher, e.g. approx. 1500 EUR/m<sup>2</sup> for Demonstration Sites in Aarhus, as this figure includes cost for new bathrooms, new kitchens, balconies, surfaces, gardening etc. These non-energy relevant cost shares are not part of READY and hence, not investigated in WP7.

Table 24:Energy-related investment costs, annual reinvestment as well as annual<br/>0&M costs for building refurbishment in READY (floor area-weighted<br/>average values excl. VAT)

Code	Planned energy-related investment costs	Max EC Support	Actual energy-related investment costs	Actual energy-related investment costs incl. EC	Reinvestment costs buildings (annual)	O&M costs buildings (ventilation)	Total annual energy- related O&M costs buildings
	€/m²	€/m²	€/m²	€/m²	€/m²yr	€/m²yr	€/m²yr
SE1	100	50	244	194	6.9	0.8	7.7
SE1.1	100	50	246	196	7.0	0.8	7.8
SE3	100	50	243	193	7.6	1.8	9.4
DK1	100	50	97	48	3.0	0.4	3.5
DK2	100	50	97	48	3.0	0.4	3.5
DK3	100	50	148	98	4.8	0.9	5.7
DK4	100	50	135	85	4.3	0.9	5.2
Sum SE	100	50	244	194	7.0	0.9	7.9
Sum DK	100	50	100	50	3.1	0.5	3.6
Total	100	50	166	116	4.9	0.7	5.3

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#### 7.2 Investment costs and O&M costs regarding on-site RE production

The actual investment costs of facilities for the on-site RE production were 170 kEUR (RDS in Växjö) resp. 871 kEUR (RDS in Aarhus) or 1.04 MEUR (READY total). The EC Support for PVT systems and WW-HR is 50% of the investment costs, the PV systems were not supported (see Table 25).

Code	Investment costs of on-site RE production - PV(T)	Investment costs of on-site RE production - heat pump, etc.	Total investment costs of on-site RE production	EC Support on-site RE production
	€	€	€	€
SE1.1	170,316	158,000	328,316	164,158
DK1	299,353	15,000	314,353	7,500
DK2	524,747	103,000	627,747	313,874
DK3	46,570		46,570	-
Sum SE	170,316	158,000	328,316	164,158
Sum DK	870,670	118,000	988,670	321,374
Total	1,040,986	276,000	1,316,986	485,532

Table 25: Investment costs of RES facilities in READY (Excl. VAT)

To determine the fictitious annual reinvestment and O&M costs for RES facilities, empirical lifespans and relative O&M costs for movable parts (per centage of investment costs) from Table 26 were used.

Component	Lifespan	rel. O&M costs
	years	%
PV(T) systems (non-movable parts)	30	-
Movable parts, e.g. heat pumps for PVT	20	1

The fictitious annual reinvestment costs and estimated annual O&M costs are presented in Table 27.

Code	Reinvestment costs RE production - PV(T) (annual)	Reinvestment costs RE production - heat pumps, etc.	O&M costs (heat pumps)
	€/yr	€/yr	€/yr
SE1.1	5,677	7,900	3,283
DK1	9,978	750	3,144
DK2	17,492	5,150	6,277
DK3	1,552	-	466
Sum SE	5,677	7,900	3,283
Sum DK	29,022	5,900	9,887
Total	34,700	13,800	13,170

Table 27:Annual reinvest and O&M costs of on-site RE production in READY (Excl.<br/>VAT)

The energy prices for electricity and district heating in Aarhus and Växjö are listed in Table 28 resp. Table 29.

City (currency)	Energy price incl. VAT	ИАТ	Energy price excl. VAT	Energy price excl. VAT
	DKK/kWh resp. SEK/kWh	_	DKK/kWh resp. SEK/kWh	EUR/kWh
Aarhus (DKK)	1.8854	25%	1.50832	0.202
Växjö (SEK)	1.7760	25%	1.4208	0.134

Table 28: Energy prices for electricity in Aarhus and Växjö

Table 29: Energy prices for district heating (variable part) in Aarhus and Växjö

City (currency)	Energy price incl. VAT	VAT	Energy price excl. VAT	Energy price excl. VAT
	DKK/kWh resp. SEK/kWh	-	DKK/kWh resp. SEK/kWh	EUR/kWh
Aarhus (DKK)	0.52	25%	0.42	0.056
Växjö (SEK)	0.6344	25%	0.50	0.048

<sup>44</sup> As in Växjö, the pure heat price is very low, the heat cost impact of capacity reduction was included as well.

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#### 7.3 Simple payback time

As the name indicates, the simple payback time is a simple calculation of the number of years prior to investment has been paid back only due to the annual energy savings. This calculation method does not include the inflation, interests, technical lifetime of the installed measures or changes in the energy prices. On the other hand, it is a term that is easy to understand. However, there is a risk that a simple payback time of more than 10-15 years easily can sound unattractive even though the technical lifetime of the measure is 20 years or more.

The simple payback time is calculated as:

 $Payback \ period \ = \frac{Investment \ costs}{Annual \ savings \ in \ energy \ costs \ - \ 0\&M \ costs}$ 

Simple payback time Table 30 shows the simple payback times for the energy-related investment costs of the building refurbishment and the investment costs of the installation of RES facilities in READY. The values are given for a calculation variant considering EC Support and for a calculation variant without considering the EC Support for the energy saving/RE production measure.

Annual operating and maintenance (O&M) costs related to energy savings are in general assumed to be 1% of the energy-related investment costs of the corresponding facility, when there are movable parts involved (e.g. ventilation, heat pumps). For systems without or with very few movable parts, O&M costs were neglected.

Code	Building refurbishment		RE pro	duction
	excl. EC Support	incl. EC Support	excl. EC Support	incl. EC Support
	years	years	years	years
SE1	72	57	N/A	N/A
SE1.1	62	50	78	39
SE3	63	50	N/A	N/A
DK1	8	4	12	12
DK2	10	5	33	17
DK3	19	13	9	9
DK4	11	7	N/A	N/A
Sum SE	70	56	78	39
Sum DK	9	5	20	13
READY	34	25	24	15

 Table 30:
 Simple payback time incl./excl. EC Support concerning building

 refurbishment and RE production in READY (excl. O&M costs)

In order to perform these calculations, several assumptions had to be made and not all desired input values were available. For the sake of simplicity, the electricity consumption of heat pumps (basically from solar PV with a low marginally value) in PVT and WW-HR systems were not included in the payback times regarding RE production (but included in the buildings' electricity consumption (BOPS)). Hence, the calculated simple payback times should be viewed regarding their order of magnitude only.

# 7.4 Simple cost of reducing greenhouse gas emissions

As the name indicates, the simple cost of reducing greenhouse gas emissions<sup>45</sup> (CO<sub>2</sub> emission saving cost) is a simple calculation of the cost of saving one kg resp. ton CO<sub>2</sub>. This characteristic value considers investment costs, periodically incurred reinvestment costs, O&M costs, energy cost savings due to reduced energy consumption and on-site RE production as well as the achieved saving of CO<sub>2</sub> emission.

This simplified calculation method does not include the inflation, interests or changes in the energy prices, but the technical lifetime is considered in the fictitious annual (re)investment costs (see below).

For the calculation of (simple) GHG saving costs, it is irrelevant, whether the costs and savings refer to a period of one year, ten years or 50 years. In this report, costs and savings from one year were used. Investment costs and reinvestment costs are therefore allocated on an annual basis using the term "reinvestment costs". In this report, the GHG reduction cost was calculated as:

 $CO2\ emission\ saving\ cost = \frac{an.\,(re)invest.\,\&O\&M\ costs - an.\,e.\,cost\ savings}{an.\,CO2\ emission\ savings}$ 

Positive calculation results (> 0, no sign) mean that the total cost of reducing greenhouse gas emissions are higher than the achieved energy cost savings, while negative calculation results (< 0, "-" sign) mean that the total costs to achieve  $CO_2$  emission savings are lower than the cost savings due to energy savings. Hence, negative GHG saving cost values are preferable.

Analogously to the calculation of the simple payback time, several assumptions were necessary and the electricity consumption of heat pumps in PVT and WW-HR systems were also not included in this approach. Therefore, the calculated values of the simple cost for reducing GHG emissions should also be viewed regarding their order of magnitude only.

BaselineAt the READY project start, the expected cost of reducing greenhouse gasemissions due to building refurbishment and RE production was roughly

 $<sup>^{45}</sup>$  In this report, the terms "CO<sub>2</sub> emission saving costs", GHG saving costs and "costs of reducing greenhouse gas emissions" is used interchangeable.

https://cowi.sharepoint.com/sites/A064318-project/Shared Documents/03 Deliverables/04 Reporting/07 WP7/D.7.3/04 Final Documents/D7.3 Evaluation of the operational monitoring data of the demonstration projects\_v2.4 final.docx

calculated. According to this calculation, in Växjö, the  $CO_2$  emission saving costs were expected to be -283 EUR/ton compared to -55 EUR/ton in Aarhus.

Actual situation According to the monitoring data, in **Växjö**, the costs for saved CO<sub>2</sub> emissions due to building refurbishment is 490 EUR/ton and 484 EUR/ton due to RE production at the READY Demonstration Sites. Considering EC support in this calculation, the CO<sub>2</sub> emission saving costs fall to 329 EUR/ton (building refurbishment) resp. 49 EUR/ton (on-site RE production). CO<sub>2</sub> emission savings due to further energy saving measures (e.g. RDS SE-DH) are excluded.

> These positive values mean that the total costs to achieve CO<sub>2</sub> emission savings are higher than the cost savings due to energy savings. Reasons for this are the relatively high energy-related investment costs for building refurbishment (244 EUR/m<sup>2</sup> compared to 100 EUR/m<sup>2</sup> in Aarhus), the low variable prices for heat from district heating and high investment costs of some RES facilities, e.g. WW-HR facilities. In future, the economic feasibility may be improved due to better operation settings gained with experience.

In **Aarhus**, the CO<sub>2</sub> emission saving costs are negative values (-163 EUR/ton regarding building refurbishment and -117 EUR/ton regarding on-site RE production), considering EC support they are even lower.

These negative values mean that the energy cost savings and earnings from RE production are higher than the sum of all relevant expenses and confirms economic feasibility. The 1 MW sea water-fed heat pump and further energy saving measures are not taken into consideration but would not lead to worse results.

These results from Aarhus are even so good that they can compensate the higher CO2 emission saving costs in Växjö, hence the area-weighted average costs of GHG emission saving in READY confirm the cost efficiency of the whole project. In READY, the overall CO2 emission saving costs regarding building refurbishment is -77 EUR/ton and -84 EUR/ton regarding the on-site RE production. The simple cost of reducing GHG emissions are listed in Table 31.

Code	<b>Building refurbishment</b>			RE pro	duction
	excl. EC Support	incl. EC Support		excl. EC Support	incl. EC Support
	€/ton	€/ton		€/ton	€/ton
SE1	488	308	Ī	N/A	N/A
SE1.1	517	327		484	49
SE3	485	394		N/A	N/A
DK1	-163	-195	Ī	-169	-171
DK2	-168	-210		-30	-153
DK3	-100	-145		-189	-189
DK4	-100	-132		N/A	N/A
Sum SE	490	325		484	49
Sum DK	-163	-199	Ī	-117	-166
READY	-77	-129		-84	-154

Table 31: Co.	sts for CO <sub>2</sub> emission	on savings in READY
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#### Conclusion

The economic analysis could prove the cost effectiveness of READY, nevertheless the data shows that in future projects some optimisations could be done, learning from experiences made in READY.

Further investigations on the relatively high energy-related investment costs for building refurbishment in Växjö and further Research & Development (R&D) concerning the technologies Photovoltaic Thermal (PVT) systems and Waste Water Heat Recovery (WW-HR) systems in future are highly recommended.

Nevertheless, it should be mentioned that the investment in energy saving measures as performed in READY is not only beneficial to energy savings, but also have an impact on several further aspects, e.g. the tenants' health and comfort, the lifespan of building components, etc. Therefore, and because of the gathered knowledge about the applied technologies, the demonstration activities in READY are a success.

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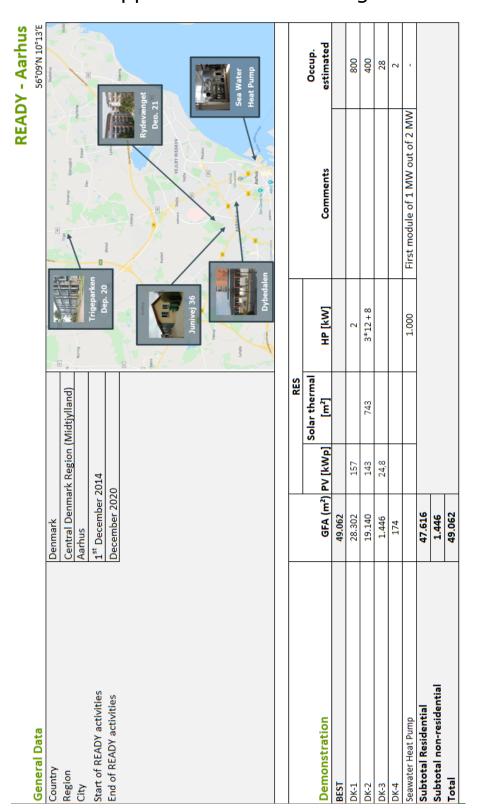
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### References

- D.3.1.1 Report describing the feasibility of heat recovery from waste water, PVT and heat storage in multi-family buildings and recommendations for demonstration including final design notes (UNI-DK)
- D.5.1.1 Documentation of performed refurbishment hand-out certificate (HOUSE-DK)
- D.5.5.1 Documentation of use of 2nd life batteries and the integration with an energy system with a high amount of renewables(LB-DK)
- D.5.5.2 Documentation of EV battery charging demonstration (EON-DK)
- D.6.2 Report on energy performance of the project in close collaboration with WP7 (CA-SE)
- D.6.4 Report on energy performance of the project in close collaboration with WP7 (VEAB-SE)
- D.8.3 Market assessment for READY set of solutions (LGI)
- D.8.5 Replicability assessment for READY solutions (LGI)



## Appendix A – Monitoring data sheets

			Ringg		-		· -·· -/
General Data					Rydevæ	enget 105-1	131, Aarhus
Refurbished Building	District 21 - Rydevænget						
Year built	1970-1973	THEFT	-				
Year refurbished	1990						
Address	Rydevænget 105-131				-	-	
Building function	Social housing			11.1	ISS ISANANANA		
Building type	Apartments						
Number of Apartments	163						
Number of Occupants	Approximately 400						
Gross Floor Area (m <sup>2</sup> )	14.151						
Gross Volume (m <sup>3</sup> )	39.623						
• •							
Net Heated/Cooled Area (m <sup>2</sup> )	11.321						
Net Heated/Cooled Volume (m <sup>3</sup> )	28.302						TITLE
Basement Type	Parterre					No in	A Provent
Attic Type	Roof apart., piched w. PV	A PROPERTY AND	-				
Total Investment cost [Euro]	9.86 mio. (VAT excl.)		6		0	-	
Building Features			Defe		Project Target		Actual
External walls	Concrete candwich I aut	W/m²K	Before 0,70	practice	(BEST) 0,15	Design	(2019/20)
	Concrete sandwich + ext.			0,30	,	0,17	0,12-0,32
Roof	Wooden structure + sheet	-	0,50	0,20	0,10	0,12	0,09-0,12
Ground floor	-	W/m²K	0,75	0,20	0,30	0,30	0,60
Windows (frame & glass)	Aluminum/wood frame	W/m²K	n.a.	n.a.	n.a.	0,90	0,90
Average U-value of glazings	-	W/m²K	2,90	1,40	0,80	-	0,53-0,59
Average g-value of glazings	-	-	n.a.	none	0,50	-	n.a.
Ventilation Flow Rate	126 m <sup>3</sup> /h per apartment	h <sup>-1</sup>	0,70	0,50	0,3-0,6	0,30	0,30
Thermal Bridges	150 mm extra insulation l	ayer in the	external co	lumns			
Air tightness & n50 air change ra	te -						
• •		lv in livingr	ooms and	exhaust in	kitchen and ba	throom	
Ventilation system type	Decentral units with supp	, ,					
Ventilation system type Energy saving measures	Decentral units with supp Waste water heat pump, h	, ,					
Ventilation system type Energy saving measures Water saving measures	Decentral units with supp Waste water heat pump, h Taps	, ,					
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Full year data not available

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1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1	jan-19	150.299	11					146.114	127.299	127.299						2.000	24.476	771	23	318
10         13385         6         14300         5500         10511         10581         16840         5310         7156         715         724         724           10         34333         5         97300         5500         5310         1736         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713         5713 <th>feb-19</th> <th>141.624</th> <th>10</th> <th></th> <th></th> <th></th> <th></th> <th>118.845</th> <th>116.624</th> <th>116.624</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>1.920</th> <th>23.521</th> <th>974</th> <th>26</th> <th>329</th>	feb-19	141.624	10					118.845	116.624	116.624						1.920	23.521	974	26	329
10         8434         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1 <th>mar-19</th> <th>133.885</th> <th>6</th> <th></th> <th></th> <th></th> <th></th> <th>105.114</th> <th>108.885</th> <th>108.885</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>2.081</th> <th>23.810</th> <th>628</th> <th>27</th> <th>342</th>	mar-19	133.885	6					105.114	108.885	108.885						2.081	23.810	628	27	342
10         3437         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2 <th>apr-19</th> <th>88.514</th> <th>9</th> <th></th> <th></th> <th></th> <th></th> <th>74.491</th> <th></th> <th>61.114</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>8.644</th> <th>21.905</th> <th>776,4</th> <th>27,4</th> <th>322,7</th>	apr-19	88.514	9					74.491		61.114						8.644	21.905	776,4	27,4	322,7
10         20000         1         55000         5000         5401         17300         0000         5401         17300         0000         5401         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300         17300	maj-19	34.873	2					53.314		8.273						10.885	27.585	977,6	34,6	406,3
1-10         2000         1         3700         2000         533         1736         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0	jun-19	20.000	1					0	0	0						8.983	19.308	718	23	279
13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13<	jul-19	20.000	1					0		0						2.505	23.842	736	29	263
1         1         5         0         1         5         0         5         1         2         0         5         1         5         1         2         1         2         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1	aug-19	13.000	1						0	0						1.788	20.975	515	19	175
10         66439         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1 <th>sep-19</th> <th>21.003</th> <th>1</th> <th></th> <th></th> <th></th> <th>17.309</th> <th>22.691</th> <th>4.003</th> <th>4.003</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>2.076</th> <th>25.114</th> <th>648</th> <th>22</th> <th>225</th>	sep-19	21.003	1				17.309	22.691	4.003	4.003						2.076	25.114	648	22	225
1-10         92.000         1.700         7.73         1.700         7.73         1.700         7.73         1.700         7.73         1.700         7.73         1.700         7.73         1.700         7.74         1.700         7.75         1.700         7.75         1.700         7.75         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.76         1.700         7.72         1.700         7.72         1.700         7.72         1.700         7.72         1.700         7.76         7.72         7.72 <t< th=""><th>okt-19</th><th>66.439</th><th>5</th><th></th><th></th><th></th><th></th><th>41.114</th><th>50.439</th><th>50.439</th><th></th><th></th><th></th><th></th><th></th><th>2.064</th><th>51.519</th><th>733</th><th>19</th><th>194</th></t<>	okt-19	66.439	5					41.114	50.439	50.439						2.064	51.519	733	19	194
	nov-19	98.066	7					60.691	84.066	84.066						1.649	61.431	828	16	158
	dec-19	130.956	6					122.114		113.956						1.684	58.551	882	18	187
2.0 $114.000$ $11.000$ $17.00$ $7.26$ $116.114$ $133.44$ $81.400$ $39.33$ $2.227$ $11.26$ $12.24$ $230$ $16.33$ $556$ $15$ $1.100$ $1156.00$ $1156.00$ $1156.10$ $1156.10$ $1156.10$ $1156.10$ $1156.10$ $116.12$ $126.12$ $16.234$ $16.33$ $55.90$ $120$ $1.100$ $1156.00$ $1156.10$ $1156.10$ $1156.10$ $1156.10$ $1156.10$ $1156.10$ $1126.10$ $124.10$ $224.10$ $210$ $2.1000$ $2590$ $11700$ $1156.10$ $1156.10$ $1156.10$ $1156.10$ $1126.10$ $124.10$ $224.10$ $210.10$ $2.1000$ $2100$ $2590$ $1156.10$ $1156.10$ $1156.10$ $1126.10$ $126.10$ $214.10$ $214.10$ $214.10$ $214.10$ $2.1000$ $2100$ $2108$ $4699$ $17306$ $5199$ $3125$ $1172$ $1726.10$ $120.10$ $214.10$ $214.10$ $2.1000$ $2108$ $12080$ $12080$ $2081.10$ $5193$ $2127$ $1170$ $126.10$ $214.10$ $216.10$ $2.1000$ $211.100$ $211.100$ $210.100$ $210.100$ $210.100$ $211.100$ $211.100$ $210.100$ $211.100$ $211.100$ $211.100$ $210.100$ $211.100$ $210.100$ $210.100$ $210.100$ $210.100$ $210.100$ $210.100$ $210.100$ $210.100$ $210.100$ $210.100$ $210.100$ $210.100$ $210.100$ $210.100$	TOTAL	918.660	65					744.490		674.660	0	0	0	0			382.037	9.187	284	3.199
-20         155.06         11         155.06         100         55.73         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31         157.31	jan-20	154.093	11				17.886	116.114	133.141	81.400	3.953	2.227	1.726	17.224	230	1.638	63.353	566	15	186
-20         135.204         10         154.500         173.80         115.614         111.251         69.625         39.93         22.27         172.6         172.6         173.3         66.356         819         21           -20         58.154         1         79459         16.216         46.34         78.61         11.125         16.66         17.23         14.33         20.503         359         11           -20         83.15         5.156         17.309         5.139         5.147         2.663         28.13         766         817         2.843         766         817         2.2         2.2         2.2         1.7         2.7         2.8         2.8         7.6         817         2.2         2.8         766         817         2.8         756         817         2.2         2.4         2.8         2.8         756         756         756         756         756         756         756         756         756         756         756         756         756         756         756         756         756         756         756         756         756         756         756         756         756         756         756         756         756	feb-20	155.008	11					120.768	130.310	74.574	3.698	2.084	1.614	16.112	290	1.894	52.707	660	17	238
-20         58.15         4         79459         16.216         4.634         17.305         4.534         5.39         38.11         39.079         38.215         1.670         1.668         2.550         1.433         2053         5343         736         1.13           10         20.610         2.460         17.886         50.014         5.159         5.157         1.724         1770         2.053         2.4843         786         129           10         24.4602         2.188         4.460         17.866         5.004         5.459         5.205         1.724         1770         2.333         2.355         1.670         16.668         1.2.33         2.355         2.564         2.35         2.843         756         2.32           10         2.5537         2         2.33057         1.586         6.001         0         3.835         2.225         1.706         17.24         13.757         2.33         2.335         2.337         17.569         17.56         17.56         17.56         2.35         17.56         2.35         2.484         2.56         2.56         2.56         2.56         2.56         2.56         2.56         2.56         2.56         2.56 <td< th=""><th>mar-20</th><th>136.204</th><th>10</th><th>-</th><th></th><th></th><th></th><th>115.614</th><th>111.251</th><th>69.625</th><th>3.953</th><th>2.227</th><th>1.726</th><th>17.224</th><th>1.670</th><th>2.348</th><th>65.356</th><th>819</th><th>21</th><th>295</th></td<>	mar-20	136.204	10	-				115.614	111.251	69.625	3.953	2.227	1.726	17.224	1.670	2.348	65.356	819	21	295
-20         30.610         2         88.3398         21.438         4.699         17.886         50.014         5.159         5.230         3.955         1.725         1.724         1.70         2.053         2.433         7.86         1.9           -20         21.305         16.618         17.577         938         17.377         938         17.377         938         17.377         938         17.386         1.7254         17.264         17.264         81.7         22.37           -20         21.330         21.587         52.088         17.926         3.855         2.1726         17.264         81.7         22.355         756         2.47           -21.330         21.500         27.844         11.956         17.886         46.617         3.877         2.560         3.953         2.217         17.26         17.28         17.286         2.48         2.48         2.48         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4         2.4	apr-20	58.154	4					45.934	38.112	39.079	3.825	2.155	1.670	16.668	2.550	1.433	20.503	539	11	221
-20         24.706         2         44.602         20.880         4.042         17309         6.413         0         0         3825         2155         1668         10         2147         22.640         817         22           -10         21530         2         20.483         17.577         958         17.866         0         0         3.953         2.227         17.76         17.24         18.740         2.333         12.355         756         24           -20         25537         2         2.256         3.953         2.2155         17.76         17.24         18.740         2.333         12.355         756         24           -20         35546         3         2.527         1.756         17.24         18.740         2.333         12.355         756         24           -20         35546         3         2.051         2.051         17.61         16.668         12.36         0         28         24         28         28         28         28         28         28         28         28         28         28         28         28         28         28         28         28         28         28         28         28 </th <th>maj-20</th> <th>30.610</th> <th>2</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>5.159</th> <th>5.290</th> <th>3.953</th> <th>2.227</th> <th>1.726</th> <th>17.224</th> <th>170</th> <th>2.053</th> <th>24.843</th> <th>786</th> <th>19</th> <th>321</th>	maj-20	30.610	2						5.159	5.290	3.953	2.227	1.726	17.224	170	2.053	24.843	786	19	321
-20         21530         2         20483         17.57         958         17.86         0         0         3.953         2.227         17.26         17.24         18.740         2.333         12.355         756         24           7:0         25537         2         33.057         21.588         6.205         17.886         0         0         3.953         2.227         17.26         19.750         2.337         12.334         826         255           7:0         25537         13.057         21.8000         17.396         46.617         3.445         3.475         3.552         2.157         17.06         17.24         19.750         2.391         2.86           7:0         7540         13.501         17.806         46.617         3.445         3.452         2.175         17.06         17.24         6.170         2.34         870         2.34           2:0         13580         16         10         16.66         3.453         3.453         3.453         3.456         2.24         3.45         3.45         3.46         3.45         3.45         3.45         3.45         3.45           2:0         13580         10         11.22         11.26	jun-20	24.706	2			4			0	0	3.825	2.155	1.670	16.668	10	2.147	22.640	817	22	322
520         25.37         2         330.57         21.88         6.205         17.886         0         0         3.953         2.227         17.26         17.24         19.750         2.327         12.834         826         255           12.01         35.546         3         71.900         27.844         11.956         17.309         25.747         3.877         2.556         3.825         2.155         16.668         17.860         2.563         870         28           12.01         35.501         15.301         17.396         17.324         6.110         2.969         19.758         870         28           12.01         55.502         17.886         17.325         3.825         2.177         1.724         6.110         2.969         2.978         2.94         2.97           17.01         14.5         14.5         3.455         14.667         7.286         3.953         2.237         1.724         7.60         3.493         8.94         2.97         2.73         2.74         2.79         2.74         2.79         2.74         2.99         2.97         2.74         2.99         2.97         2.74         2.99         2.97         2.74         2.69         2.9	jul-20	21.530	2							0		2.227	1.726	17.224	18.740	2.333	12.355	756	24	318
-20         35.546         3         71.900         27.341         11956         17.300         26.747         38.77         2.560         3.825         2.155         16.68         12.860         2.739         17.558         870         2.8           2.01         53.408         4         82.502         18000         16.59         17.86         17.24         6.110         2.969         19.888         894         29           -20         77.231         5         105.243         20.981         3.522         17.324         6.110         2.969         19.888         894         29           -20         77.231         5         105.243         20.981         3.522         17.246         17.24         6.110         2.969         19.888         894         29           -20         135.820         10         142.274         211.67         6.9935         5.4425         5.3755         3.825         2.172         17.24         760         3.55.91         970         371         273         371         373         3         3           (e)         97.847         64.667         72.868         3.953         2.0335         28.149         867         263         355.291 </th <th>aug-20</th> <th>25.537</th> <th>2</th> <th></th> <th></th> <th></th> <th></th> <th>0</th> <th>0</th> <th>0</th> <th></th> <th>2.227</th> <th>1.726</th> <th>17.224</th> <th>19.750</th> <th>2.327</th> <th>12.834</th> <th>826</th> <th>25</th> <th>294</th>	aug-20	25.537	2					0	0	0		2.227	1.726	17.224	19.750	2.327	12.834	826	25	294
120         53.408         4         82.502         17.800         15.86         46.617         31.455         32.553         3.953         2.227         17.24         6.110         2.969         19.898         894         291           7.231         57.231         105.243         2.0931         3.552         17.309         66.953         52.425         53.755         3.855         2.157         1.724         6.110         2.959         28.149         867         29           7.201         907.847         64         11.2274         21.500         5.942         17.868         3.953         2.227         1.726         17.224         25.04         970         349         28.149         867         29         3         345         25.91         971         273         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3	sep-20	35.546	3					26.747	3.877	2.560		2.155	1.670	16.668	12.860	2.739	17.558	870	28	304
r231         5         105.243         20.981         3.522         17.309         66.953         5.2.425         5.3.755         3.8.25         2.157         1.6.68         2.970         3.594         25.094         970         34           ::::::::::::::::::::::::::::::::::::	okt-20	53.408	4					46.617	31.455	32.253		2.227	1.726	17.224	6.110	2.969	19.898	894	29	313
:20         135.820         10         142.274         21.500         5.942         17.886         100.368         110.367         72.868         3.953         2.227         17.26         17.24         760         3.459         28.149         867         2.29           TMI         907.847         64         1132.919         245.081         65.027         211.167         698.063         616.098         431.403         46.667         26.295         203372         66.110         28.933         355.291         9371         273         3           e)         918.660         65         84         15         43         44         30         3         22         11.67         69.333         355.291         9371         273         3           e)         918.660         65         84         15         43         44         30         3         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         3         2         3         2         3         2         3         2         3         2         3         2	nov-20	77.231	5					66.953	52.425	53.755		2.155	1.670	16.668	2.970	3.594	25.094	970	34	334
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	dec-20	135.820	10					102.888	110.367	72.868	3.953	2.227	1.726	17.224	760	3.459	28.149	867	29	297
e)         918.660         65         84         17         5,4         15         5,3         48         48         48         0         0         0         0         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3	TOTAL	907.847	64				211.167	698.063	616.098	431.403		26.295	20.372	203.350	66.110	28.933	365.291	9.371	273	3.441
918.660     65     84     17     5,4     15     53     48     48     0     0     0     0     3       907.847     64     80     17     4,6     15     49     44     30     3     2     1     14     5     2       20     907.847     64     80     17     4,6     15     49     44     30     3     2     1     14     5     2	(Before)		;														1			
<b>20</b> 907.847 64 80 17 4,6 15 49 44 30 3 2 1 14 5 2 2 2 1 3 4 5 2 2 3 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	2019	918.660	65					53		48		0 (	0,	0;	0 1	m d	27			
	2020 mean 20	907.847	64 64					49 49		30		7 6		14 14	л <b>и</b>	7 6	97 97			
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 Construction works ongoing

https://cowi.sharepoint.com/sites/A064318-project/Shared Documents/03 Deliverables/04 Reporting/07 WP7/D.7.3/04 Final Documents/D7.3 Evaluation of the operational monitoring data of the demonstration projects\_v2.4 final.docx

General	Data					Rydeva	ænget 105-:	131, Aarhus
New RES		Ph	otovoltaic sy	rstem				
Year insta	lled		2020					
Installatio	on type		PV					
Address			Rydevænge	t	-			
Installed o	apacity [kWp]		157,38 kW					
Quantity [			516 panels					
Area [m <sup>2</sup> ]			827					
Slope [°]			25°					
Orientatio	n	Soi	uth, east and	west				1 I Linker
Est. annua	l prod. [kWh]		136.306 kW			-	غل ال	
Total Inve	stment cost [€]		165,000€					
	Electricity		Climate		Performance		Electricity	
	Electricity produced	Normal	Actual	Actual				Used from
Period		year	tilted	tilted	Efficiency	Sold	Bought	PV
		global		irradiation				
		radiation	on PV (calc)	on PV (calc)				
	kWh	kWh/m²	kWh/m²	kWh	%	kWh	kWh	kWh
jan-20	230	19	13		2	0		230
feb-20	290	36	29	23,919	1	0		290
mar-20	1,670	83	89	73,764	2	0		1,670
apr-20	2,550	122	142	117,835	2	0	20,503	
maj-20	170	148	180	148,614	0	0	24,843	
jun-20	10	170	182	150,695	0	0	22,640	
jul-20	18,740	161	145	120,201	16	6 <i>,</i> 095	12,355	
aug-20	19,750	122	143	118,100	17	7,584	12,834	
sep-20	12,860	83	92	76,263	17	5,418	17,558	
okt-20	6,110	44	39	32,461	19	1,008	19,898	
nov-20	2,970	19	18	15,221	20	0	25,094	
dec-20	760	14	6	4,755	16	0	28,149	
TOTAL	66,110	1,020	1,080	892,825	7	20,106	183,875	46,004

### Ringgården afdeling 21 (BEST-DK-1)

The PV system was not fully operational.

#### .)

General Data			Ringg	ården a	afdeling 2		
General Data	District 21 -			-	FJældevæ	nget 110-1	.36, Aarhus
Refurbished Building	Fjældevænget						
Year built	1970-1973						
Year pullt Year refurbished	1970-1973						
Address	-						
	Fjældevænget 110-136			No.			-
Building function	Social housing		And in case of the local division of the loc				E
Building type	Apartments	1.B, 10			The March 191		
Number of Apartments	164						
Number of Occupants	Approximately 400						
Gross Floor Area (m <sup>2</sup> )	14,151					- Contraction of the	
Gross Volume (m <sup>3</sup> )	39,623		THE STATE				
Net Heated/Cooled Area (m <sup>2</sup> )	11,321			16		Seattle 1	
Net Heated/Cooled Volume (m <sup>3</sup> )	28,302	- Chi	0.00			E.K.	
Basement Type	Parterre	and the		The seal			
Attic Type	Roof apart., piched w. PV						
Total Investment cost [Euro]	9.86 mio (VAT excl.)	A Carton				affle	1
Building Features			Before	Normal practice	Project Target (BEST)	Design	Actual (2019/20
External walls	Concrete structure	W/m²K	0.70	0.30	0.15	0.17	0,12-0,32
Roof	Wooden structure + sheet	W/m²K	0.50	0.20	0.10	0.12	0,09-0,12
Ground floor	-	W/m²K	0.75	0.20	0.30	0.30	0.60
Windows (frame & glass)	Aluminum/wood frame	W/m²K	n.a.	n.a.	n.a.	0.90	0.90
Average U-value of glazings	-	W/m²K	2.90	1.40	0.80	-	0,53-0,59
Average g-value of glazings	-	-	n.a.	none	0.50	-	n.a.
Ventilation Flow Rate	126 m <sup>3</sup> /h per apartment	h <sup>-1</sup>	0.70	0.50	0,3-0,6	0.30	0,30
Thermal Bridges	150 mm extra insulation	aver in the			- / / -		- /
Air tightness & n50 air change rat							
Ventilation system type	Decentral units with supp	ly in living	rooms and	d exhaust i	n kitchen and h	athroom	
Energy saving measures	Waste water heat pump, h		-				
Water saving measures	Taps		, mourai		chovation/apai	tinento	
Special building materials	Roof apartments						
Type of Shading	Partial external solar sha	ding (balc	onies)				
			formatio	<b>o</b> n			
Energy Systems		Othern	Inormatio		the second s	~	
District Heating connection	yes		100		/		_
Photovoltaic - grid connected	yes						T
Solar thermal - flat plate	no		1000				
Heat pump demo for waste water	yes		and the second	N			
Boiler	no			TIT			
			255		Ringgårder Fjældevænge	n it	
			-				
			1000	10000			
			and the second division of				
			-	191			
				- 111			
			100				Ŧ
	IL LOUGH & LA MERICAN		St. Same	HE			
				it in the second		·	- Aler
	A State of the sta		Complete and			· Jacks	
	22		ET.		the second	-	1 Mar
12-11-							
		Existing	Project				
		building	Target				
Key Energy figures	kWh/year/m² gross area	(referenc	(BEST)	Design	2019	2020	2021
Total Energy Demand		194.0	74.0	53.5	47.8	65.2	
Total heat		155.0	55.0	49.1	47.8	61.8	
Space heating		121.0	36.0	32.0	22.0	44.8	
Domestic hot water		34.0	19.0	17.1	25.9	17.0	
Pipe heat losses		Included	Included	Included	Included	Included	
Total electricity (Building operations)					'n.a.		
	ווו	39.0	19.0	4.4		3.4	
Ventilation		14.0 12.0	7.0	2.7	'n.a.	1.9	
HEATING SYSTEM		1 1 2 (1					

Full year data not available

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12.0

13.0

50.0

Lighting + Heating system

Household electricity

Laundry

								Ringgår	Ringgården afdeling	21	(BEST-DK-1	K-1)								
Address					Ē	Fjældevænget 110-	et 110-136	8												Τ
Typology of Dwelling	Dwelling				Social hou	Social housing / Multi-fam	ti-family buildings	Ş												
Occupants number	number					Approx. 600														
Occupants type	type				d	Residential	ntial Dinggarden													
Gross floor area (m <sup>2</sup> )	area (m²)				B	1.1.01 E11115 NII 1.4.1.5.1	11.5441451													
		;				141	1						Thomas winite w						Mator	
	Total Total	otal/m²	Total heating		Heat losses	Heat losses	Space heating	Space <b>†</b> heating	Space heating	Building operation	Vent.	Lighting+ Heating	>	-V4	La undry	Total	Construc-		5	Hot
Monito-				hot water	МНО	Н		(Normalized) (Normalized)		total		system	holds	production			tion site	water		water
Period	kWh	kWh/m²	kWh	kWh	kWh		kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	m³	m³	m³
jan-19	159,385	11	184,000	27,000	10,047	12,126	144,874	132,385								24,861		851	39	324
feb-19	159,040	11			2(	10,953	119,047	132,040								23,677		826	40	121
mar-19	136,942	10			-412	12,126	107,874	108,942								23,902		859	39	543
a pi - 19 maj - 19	38.766	0 m	000'611	28.800	7.687	12.126	54.974	. 1926.6								28.974		0/2.4 1098.6	4.5.0 55.2	403.5
jun-19	23,000	2					9,265	0								22,024		833	44	290
jul-19	25,000	2	46,000	25,000	7,994	12,126	8,874	0								26,277		956	50	325
aug-19	18,000	1	33,000	18,000	6,227	12,126	2,874	0								18,050		677	35	225
sep-19	31,362	2	75,000	24,000	8,093	11,735	39,265	7,362								24,787		884	45	304
okt-19	115,207	80	132,000	27,000	9,680	12,126	92,874	88,207								25,695		910	46	331
nov-19	125,023	6	152,000	25,000	8,936	11,735	115,265	100,023								23,680		819	39	307
dec-19	163,912	12	177,000	27,000	10,256	12,126	137,874	136,912								23,920		864	42	320
TOTAL	1,106,118	78	1,	,	111,432	142,774	909,226	795,118	0	0	0	0	0		0	288,855		10,450	518	3,814
jan-20	167,875	12				19,311	121,889	139,762	94,613		2,227	2,126	17,224	'	2,495	25,851	1,779	793	43	294
feb-20	174,016	12				18,066	130,363	140,663	86,679		2,084	1,812	16,112	'	2,470	35,598	11,526	826	44	285
mar-20	134,525	10	1		7	19,311	108,289	104,202	80,927	3,923	2,227	1,695	17,224	1	2,688	40,224	16,152	905	48	309
a pr-20	50,442	4				18,689	31,582	26,204	45,422	3,968	2,155	1,812	16,668	'	1,528	22,449	0	703	28	284
maj-20	36,111	m				19,311	33,013	6,733	6,149	3,981	2,227	1,754	17,224	'	1,827	35,800	11,728	879	20	316
jun-20	24,274	2			9,509	18,689	1,392	0	0	3,968	2,155	1,812	16,668	'	1,413	26,817	2,746	774	37	206
jul-20	22,065	2				19,311	0	0	0	3,981	2,227	1,754	17,224	1	1,293	19,822	0	548	24	131
aug-20	19,211	<del>.</del> –			7	19,311	0	0	0		2,227	1,431	17,224	1	1,162	22,044	0	576	19	82
sep-20	18,550				6,413	18,689	27,731	4,292	2,975		2,155	1,812	16,668		1,277	36,050	11,979	553	18	74
	185,44	ηι		_	10,001	112,91	28,457 55.214	25,/34	37,488	3,981	2,221	1,754 1,017	11,224	'	1,458	45,894	10,400	220	70	80
02-0011	7 4 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	0 0	100,/82	10,0/9		10,011	05,214	100,001	62,48U	3,308	CCT/7	4 7F 4	200/0T	'	UC8/T	100/04	10,409	070	23	151
TOTAL	101/047	91	•	ſ		TTC/CT	507,00 644,603	624177	CC01103	TOC'C	76 7 06	<b>71 220</b>	203 2ED		21 600	205 707	111 7E1	VCV 8	35.2	7 C7 C
(Before)	0.00/330	6			310/111	000/02 2	000/110	117/200	C 344 T D C	020/11	00101		0000		000/14		10//171	1710		2,464
2019	1,106,118	78			7.9	10.1	64.3	56.2	0.0	0.0	0.0		0.0	0.0	0.0	20.4	0.0			
2020	922,690	65			8.1	16.1	45.6	44.8	35.4	3.4	1.9	1.5	14.4	0.0	1.5	28.0	8.1			
mean 20	922,690	65	76.3	17.0	8.1	16.1	45.6	44.8	35.4	3.4	1.9		14.4	0.0	1.5	28.0	8.1			
											XXXXXXX	Measured data	1 data							
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											XXXXXXX	Calculated data	d data							
												Construct	ion work.	Construction works ongoing						
										•		_								

<sup>106</sup> D.7.3 EVALUATION OF THE OPERATIONAL MONITORING DATA OF THE DEMONSTRATION PROJECTS

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			Ringgå	irden A	fdeling 2	0 (BES <sup>-</sup>	Г-DК-2)
General Data					Trige	Parkvej 1	-39, Aarhu
Refurbished Building	District 20 - Trigeparken	and and					-
Year built	1980 (1994)	A State					
Year refurbished	2019 Trian Dankusi 1, 20	Chinese and a second					
Address	Trige Parkvej 1-39			\$ B			
Building function Building type	Social housing Apartments/Multi-family					-	
Number of Apartments	153		FF H				Ter.
Number of Occupants	Approx 400	8 I I I I I I I I I I I I I I I I I I I	X				
Gross Floor Area (m <sup>2</sup> )	19.140			1			
Gross Volume (m <sup>3</sup> )	53.592	A THE TYPE					
Net Heated/Cooled Area (m <sup>2</sup> )	15.312						
Net Heated/Cooled Volume (m <sup>3</sup> )	38.280					la P.	
Basement Type	Partly parterre					E X	
Attic Type	Flat roof			- ler			
Total Investment cost [Euro]	16.4 mio. (VAT excl.)		a statistic for the	the man	Catherine Halling on	Second Second	
				Normal	Project Target		Actual
Building Features			Before	practice	(BEST)	Design	(2019/20
External walls	Wooden cassette	W/m²K	0,70	0,30	0,17	0,15	0,15
Roof	Concrete deck + wood	, W/m²K	0,50	0,20	0,12	0,12	0,12
Ground floor	Concrete structure	W/m²K	0,75	0,20	0,30	0,30	0,30
Windows (frame & glass)	Aluminum/wood frame	W/m²K	n.a.	n.a.	n.a.	0,80	0,80
Average U-value of glazings	-	W/m²K	2,90	1,40	0,80	0,80	<0,80
Average g-value of glazings	-	-	n.a.	none	0,50	0,45	0,45
Ventilation Flow Rate	126 m <sup>3</sup> /h per apartment	h <sup>-1</sup>	0,70	0,30	0,3-0,6	0,30	0,30
Thermal Bridges	Reduced						
Air tightness & n50 air change rate	- Decentral balanced syste	nac with curr	ماير الما مر		d ovhoust in kit	ahan and k	athroom
Ventilation system type Energy saving measures	Waste water heat pump, h		, ,				
Water saving measures	Taps, reduced circulation		, 11301010	11, 1 V 1 11y01	nu near pumps,	, battery, c	01111013
Special building materials	Wooden cassette, PVT par						
Type of Shading	External solar shading, or		alconies				
Energy Systems		Other info	ormation				
District Heating connection	yes						
Photovoltaic - grid connected	yes						
Solar thermal - flat plate	yes, PVT						
Heat pump(s) Boiler	yes no						
				k line line line line line line line line			
Key Energy figures	kWh/year/m <sup>2</sup> gross area	Existing building (reference)	Project Target (BEST)	Design	2019	2020	2021
	kWh/year/m <sup>2</sup> gross area	building	Target	Design 54,6	2019 n.a.	2020 <b>50,6</b>	2021
Total Energy Demand Total heat	kWh/year/m <sup>2</sup> gross area	building (reference) 181 155	Target (BEST) <b>70</b> 59	<b>54,6</b> 50,3	<b>n.a.</b> 60,2	<b>50,6</b> 47,4	2021
Total Energy Demand Total heat Space heating	kWh/year/m <sup>2</sup> gross area	building (reference) 181 155 121	Target (BEST) <b>70</b> 59 39	<b>54,6</b> 50,3 37,2	n.a. 60,2 51,5	<b>50,6</b> 47,4 27,8	2021
Total Energy Demand Total heat Space heating Domestic hot water	kWh/year/m <sup>2</sup> gross area	building (reference) 181 155 121 34	Target (BEST) 70 59 39 20	<b>54,6</b> 50,3 37,2 13,1	n.a. 60,2 51,5 8,8	<b>50,6</b> 47,4 27,8 9,3	2021
Total Energy Demand Total heat Space heating Domestic hot water Pipe heat losses		building (reference) 181 155 121 34 Included	Target (BEST) 70 59 39 20 Included	<b>54,6</b> 50,3 37,2 13,1 Excluded	n.a. 60,2 51,5 8,8 Excluded	<b>50,6</b> 47,4 27,8 9,3 10,3	2021
Total Energy Demand Total heat Space heating Domestic hot water Pipe heat losses Total electricity (building operatio		building (reference) 181 155 121 34 Included 26	Target (BEST) <b>70</b> 59 39 20 Included 11	<b>54,6</b> 50,3 37,2 13,1 Excluded 4,3	n.a.           60,2           51,5           8,8           Excluded           n.a.	<b>50,6</b> 47,4 27,8 9,3 10,3 3,2	2021
Total Energy Demand Total heat Space heating Domestic hot water Pipe heat losses Total electricity (building operatio Ventilation		building (reference) 181 155 121 34 Included 26 14	Target (BEST) 70 59 39 20 Included 11 7	<b>54,6</b> 50,3 37,2 13,1 Excluded 4,3 2,7	n.a. 60,2 51,5 8,8 Excluded n.a. n.a.	<b>50,6</b> 47,4 27,8 9,3 10,3 3,2 1,9	2021
Total Energy Demand Total heat Space heating Domestic hot water Pipe heat losses Total electricity (building operatio Ventilation Lighting+common ventilation	n)	building (reference) 181 155 121 34 Included 26 14 12	Target (BEST) 70 59 39 20 Included 11 7 4	<b>54,6</b> 50,3 37,2 13,1 Excluded 4,3 2,7 1,6	n.a. 60,2 51,5 8,8 Excluded n.a. n.a. n.a.	<b>50,6</b> 47,4 27,8 9,3 10,3 3,2 1,9 0,9	2021
Total Energy Demand Total heat Space heating Domestic hot water Pipe heat losses Total electricity (building operatio Ventilation	n)	building (reference) 181 155 121 34 Included 26 14	Target (BEST) 70 59 39 20 Included 11 7	<b>54,6</b> 50,3 37,2 13,1 Excluded 4,3 2,7	n.a. 60,2 51,5 8,8 Excluded n.a. n.a.	<b>50,6</b> 47,4 27,8 9,3 10,3 3,2 1,9	2021
Total Energy Demand Total heat Space heating Domestic hot water Pipe heat losses Total electricity (building operatio Ventilation Lighting+common ventilation Other energy demand (heating syst	n)	building (reference) 181 155 121 34 Included 26 14 12 13	Target (BEST) 70 59 39 20 Included 11 7 4 8	<b>54,6</b> 50,3 37,2 13,1 Excluded 4,3 2,7 1,6 -	n.a. 60,2 51,5 8,8 Excluded n.a. n.a. n.a. n.a.	<b>50,6</b> 47,4 27,8 9,3 10,3 3,2 1,9 0,9 0,4	2021
Total Energy Demand Total heat Space heating Domestic hot water Pipe heat losses Total electricity (building operatio Ventilation Lighting+common ventilation	n)	building (reference) 181 155 121 34 Included 26 14 12	Target (BEST) 70 59 39 20 Included 11 7 4	<b>54,6</b> 50,3 37,2 13,1 Excluded 4,3 2,7 1,6	n.a. 60,2 51,5 8,8 Excluded n.a. n.a. n.a.	<b>50,6</b> 47,4 27,8 9,3 10,3 3,2 1,9 0,9	2021

Ringgården Afdeling 20 (BEST-DK-2)

Full year data not available

https://cowi.sharepoint.com/sites/A064318-project/Shared Documents/03 Deliverables/04 Reporting/07 WP7/D.7.3/04 Final Documents/D7.3 Evaluation of the operational monitoring data of the demonstration projects\_v2.4 final.docx

							Ringgården Afdeling 20 (BEST-DK-2)	en Afde	oling 20	(BFST-C	(C-XC							
Address		_		Tri	Trige Parkvei	1-39	00		0									Γ
Typology of Dwelling	Dwelling		Socia	I housin	ig / Multi-1	5	ŝŝ											
Occupants number	Jumber				383													
Occupants type	type				Residentia	al												
Ownership				Bolifo	Boliforening Ringaarden	igaarden												
Gross floor area (m <sup>2</sup> )	area (m²)				19140													
	Energy						Space	Building		Li <i>e</i> hting +	Electricity	_				Cold	Water Cold	
:	<b>Total</b> Total/m <sup>2</sup>	/m <sup>2</sup> Total heating		Domestic hot water	Heat <sub>S</sub> losses <sup>S</sup>	Space heating		operation	Heating system		Ventilation apartments	PV production	Laundry	House - holds	Total		water for	Hot water
Monito- ring							(normalized)	total		ventilation		ω)	(meter number	r.)		total	laundry	
Period	kwh kwh/m <sup>2</sup>	m² kWh		kWh	kWh	kWh	kWh	kwh	kWh	kWh			kWh	kWh	kWh	m³	m³	m³
jan-19	202.402	11 257	257.957 1	14.343	28.362	215.252	188.059						8.120		40.879	1181	23,7	274,1
feb-19	181.447	9 189	189.543	9.159	28.362	152.022	172.289						#VALUE!		34.450	0	16,2	175,0
mar-19	174.912	9 119	119.500 1	14.056	28.362	77.081	160.855						#VALUE!		41.327	506	21,6	268,6
apr-19	103.151		90.200 1	12.867	28.362	48.971	90.284						#VALUE!		39.937	600	18	245,9
maj-19	30.323	2 101	101.400 1	18.101	28.362	54.936	12.222						#VALUE!		33.902	563	18	345,9
jun-19	13.156	1 52	52.700 1	13.156	39.544	0	0						#VALUE!		26.710	491	21,8	251,4
jul-19	16.222	1 40	40.900 1	16.222	24.678	0	0						#VALUE!		19.845	551	21,9	310,0
aug-19	15.035	1 35	35.900 1	15.035	20.865	0	0						#VALUE!		20.203	480	19,9	287,3
sep-19	24.300	1 83	83.400 1	16.044	28.362	38.994	8.256						#VALUE!		22.975	615	24,8	306,6
okt-19	119.928			17.092	28.362	102.745	102.836						#VALUE!		26.470	635	18,9	326,7
nov-19	130.032			9.990	28.362	136.147	120.041						#VALUE!		28.587	674	22,7	190,9
	142.240			_	28.362	129.069	130.272						1.857		33.035	787	26,1	228,7
	1.153.148	60 1.463		_	340.349	955.217	985.114	0	0	0	0		#VALUE!	0	368.320	7.083	254	3.211
jan-20	120.131	1		15.539	16.646	86.647	99.352	5.240	688	1.508	3.044	0		21.208	28.861	831	26,1	126
feb-20	107.163		97.366 1	14.237	15.572	81.513	87.954	4.973	535	1.661	2.777	0		22.085	29.365	776	30	106
mar-20	113.726		113.362 1	15.924	16.646	96.427	92.788	5.014	484	1.489	3.041	0	2.505	25.729	33.248	998	32	127
apr-20	66.552	3 72	72.075 1	15.059	16.109	55.258	45.848	5.644	826	1.830	2.988	0		23.629	31.132	985	23	138,3
maj-20	28.832	2 56	56.268 1	15.395	16.646	38.782	7.909	5.527	756	1.672	3.099	4.760	2.311	22.615	30.453	902	27	49,5
jun-20	19.215	1 27	27.425 1	13.977	16.109	11.452	0	5.238	670	1.528	3.040	16.530	1.938	18.650	30.491	1136	31,4	46
jul-20	20.919	1 30	30.025 1	15.684	16.646	13.084	0	5.234	642	1.583	3.009	13.420	2.125	17.157	30.491	1029	31,8	80,2
aug-20	20.472	1 22	22.187 1	15.298	16.646	6.265	0	5.174	647	1.334	3.193	11.780	1.932	17.650	30.491	1034	26,5	61
sep-20	22.628		38.577 1	14.864	16.109	21.966	3.124	4.640	705	1.236	2.699	7.410	2.011	20.514	30.491	962	23,3	33,3
okt-20	61.689		64.768 1	13.781	16.646	47.647	43.087	4.821	770	1.218	2.832	3.480	2.233	24.461	30.491	949	29	15,1
nov-20	84.061	4 83	83.312 1	13.123	16.109	66.991	66.151	4.788	714	1.240	2.834	1.400	2.285	27.241	30.491	993	30	15
dec-20	105.867	6 106	106.114 1	14.325	16.646	89.145	86.511	5.031	747	1.274	3.010	390	2.539	31.660	30.491	972	34	28
TOTAL	771.256	40 814	814.990 17	177.206 1	196.525	615.176	532.725	61.324	8.186	17.572	35.566	59.170	26.449	272.598	366.498	11.567	344	825
(Before) 2019	1.153.148	60	76	σ	18	50	51	m	C		2	m		14	19			
2020		40	43	6	10	32	28	ŝ	0	ц	2	3	1	14	19			
mean 20	1.153.148	40	42,6	9,3	10,3	32,1	27,8	3,2	0,4	6'0	1,9	3,1	1,4	14,2	19,1			
											Measured data	ata						
										XXXXXXX	Calculated data Measured data	data ata						
											Calculated data	lata						
									-									

# Ringgården Afdeling 20 (BEST-DK-2)

General	Data					Trige	- Parkvej 1-3	39, Aarhus
New RES		Pho	tovoltaic sys	tem	Service a site	a land	1000	
Year insta	lled		2020		Like half In	Re Dran Sta	Maria Maria	here
Installatio	on type	Combined	PV and solar	collectors				
Address			Trigeparken					7
Installed o	capacity [kWp]		143 kWp				Al	and the second second
Quantity [		12	28 panels (P\	/T)			-	A
Area [m <sup>2</sup> ]			720					
Slope [°]			0°					
Orientatio	on		West					-
Est. annua	l prod. [kWh]		105.834 kWł	ı				
Total Inve	stment cost [€]		524,747.00 €					
	The statistics		Climate		Daufarmana		The studiets	
	Electricity		Climate		Performance		Electricity	
Period	Electricity produced	Normal year global radiation	Actual tilted irradiation on PV (calc)	Actual tilted irradiation on PV (calc)	Efficiency	Sold	Bought	Used from PV
	kWh	kWh/m²	kWh/m²	kWh	%	kWh	kWh	kWh
jan-20	0	19	13	9,573	0	0	0	0
feb-20	0	36	29	20,825	0	0	0	0
mar-20	0	83	89	64,220	0	0	0	0
apr-20	0	122	142	102,589	0	0	0	0
maj-20	4,760	148	180	129,385	4	1,598	5,099	3,162
jun-20	16,530	170	182	131,197	13	10,178	1,855	6,352
jul-20	13,420	161	145	104,649	13	6,651	1,001	6,769
aug-20	11,780	122	143	102,820	11	5 <i>,</i> 070	1,284	6,710
sep-20	7,410	83	92	66,396	11	2,189	2,760	5,221
okt-20	3,480	44	39	28,261	12	78	5,647	3,402
nov-20	1,400	19	18	13,252	11	57	7,003	1,343
dec-20	390	14	6	4,140	9	0	8,621	390
TOTAL	59,170	1,020	1,080	777,308	8	25,821	33,269	33,349

Companyal Data				Dyn	edalen 1/		
General Data	Dubuda Luc 4.4					Dybedalen	1A, Aarhu
Refurbished Building	Dybedalen 1A				I P		
Year built	1989	-			I Lott	- and the line	X
Year refurbished	2019 D. hadalaa 11			VIE	M.W.	H x	-
Address	Dybedalen 1A		1	N		John I	
Building function	Administration	100		- Andre	A Dec		
Building type	Office		tion.			7 Ale	4
Number of Apartments	0			SUCCESS		THE SUPERIOR	
Number of Occupants	28						
Gross Floor Area (m <sup>2</sup> )	1.446						
Gross Volume (m <sup>3</sup> )	4.049		AND A CONTRACT	and the second sec			
Net Heated/Cooled Area (m <sup>2</sup> )	1.157				THE DAY TOTAL		
Net Heated/Cooled Volume (m <sup>3</sup> )	3.008	1 1 1 1 1 1 1 1 1 1		LT LLAND			and a state of the
Basement Type	Heated full height	1	-			A CALLER AND A CALLER	a Standard
Attic Type	Piched roof	and the		-			5
Total Investment cost [Euro]	1.6 million € (VAT excl.)		No And A Contra		-		5
				Normal	Project Target		Actual
Building Features			Before	practice	(BEST)	Design	(2019/2
External walls	Bricks with insulated cavity	W/m²K	0,70	0,30	0,15	0,15	0,15
Roof	Wooden structure	W/m²K	0,50	0,20	0,10	0,10	0,10
Ground floor	Concrete structure	W/m²K	0,75	0,20	0,30	0,24	0,24
Windows (frame & glass)	Aluminum/wood frame	W/m²K	n.a.	n.a.	n.a.	n.a.	n.a.
Average U-value of glazings	-	W/m²K	2,90	1,40	0,80	0,80	0,80
Average g-value of glazings	-	- 1	n.a.	none	0,50	0,39	-
Ventilation Flow Rate	VAV with heat recovery	h <sup>-1</sup>	0,70	0,30	0,3-0,6	0,30	0,3-0,6
Thermal Bridges	-						
Air tightness & n50 air change ra	te -						
Ventilation system type	VAV with heat recovery						
Energy saving measures	Insulation, new windows						
Water saving measures	-						
Special building materials	-						
Type of Shading	Internal screens and fixed over	rhang					
Francis Custome		Oth an ind					
Energy Systems District Heating connection	yes	Other in	ormatio	n			
Photovoltaic - grid connected	yes	4					
Solar thermal - flat plate	no	-					
Heat pump	no	-					
Boiler	no	+					
19		A land	-		Set and	Wedness of	
	J.						
Key Energy figures	kWh/year/m <sup>2</sup> gross area	Existing building (reference)	Project Target (BEST)	Design	2019	2020	2021
Total Energy Demand	kWh/year/m <sup>2</sup> gross area	building	Target	59	53	57,8	2021
Total Energy Demand Total heat	kWh/year/m <sup>2</sup> gross area	building (reference) 139 96	Target (BEST) 61 46	<b>59</b> 45	<b>53</b> 43	<b>57,8</b> 43,1	2021
Total Energy Demand Total heat	kWh/year/m <sup>2</sup> gross area	building (reference) 139 96 81	Target (BEST) 61 46 36	<b>59</b> 45 35	53 43 43	<b>57,8</b> 43,1 38,6	2021
<b>Total Energy Demand</b> Total heat Space heating Domestic hot water	kWh/year/m <sup>2</sup> gross area	building (reference) 139 96	Target (BEST) 61 46	<b>59</b> 45	<b>53</b> 43	<b>57,8</b> 43,1	2021
<b>Total Energy Demand</b> Total heat Space heating Domestic hot water	kWh/year/m <sup>2</sup> gross area	building (reference) 139 96 81	Target (BEST) 61 46 36	<b>59</b> 45 35 10,3	53 43 43	<b>57,8</b> 43,1 38,6	2021
Total Energy Demand Total heat Space heating Domestic hot water Pipe heat losses		building (reference) 139 96 81 15	Target (BEST) 61 46 36 10	<b>59</b> 45 35 10,3	53 43 43 0,5	<b>57,8</b> 43,1 38,6 0,6	2021
<b>Total Energy Demand</b> Total heat Space heating Domestic hot water Pipe heat losses Total electricity (ekskl. office equ		building (reference) 139 96 81 15 Included	Target (BEST) 61 46 36 10 Included	<b>59</b> 45 35 10,3 Included	53 43 43 0,5 Included	<b>57,8</b> 43,1 38,6 0,6 4,0	2021
Total Energy Demand Total heat Space heating Domestic hot water Pipe heat losses Total electricity (ekskl. office equ Ventilation		building (reference) 139 96 81 15 Included 43	Target (BEST) 61 46 36 10 Included 15	<b>59</b> 45 35 10,3 Included 14	53 43 0,5 Included 10	<b>57,8</b> 43,1 38,6 0,6 4,0 14,7	2021
Total Energy Demand Total heat Space heating Domestic hot water Pipe heat losses Total electricity (ekskl. office equ Ventilation Lighting		building (reference) <b>139</b> 96 81 15 Included 43 14	Target (BEST) 61 46 36 10 Included 15 7	<b>59</b> 45 35 10,3 Included 14 6,1	53           43           0,5           Included           10           5	<b>57,8</b> 43,1 38,6 0,6 4,0 14,7 6,2	2021
Key Energy figures         Total Energy Demand         Total heat         Space heating         Domestic hot water         Pipe heat losses         Total electricity (ekskl. office equiventiation         Lighting         Cooling         Office equipment		building (reference) 139 96 81 15 Included 43 14 16	Target (BEST) 61 46 36 10 Included 15 7 8	<b>59</b> 45 35 10,3 Included 14 6,1 7,6	53 43 0,5 Included 10 5 -	<b>57,8</b> 43,1 38,6 0,6 4,0 14,7 6,2 2,8	2021

# Dybedalen 1A (BEST DK-3)

						Dybe	Dybedalen 1A	A (BEST DK-3)	DK-3)						
Address					Dybedalen 1A	A									
Typology of Dwelling	lling				Office										
Occupants number	Jer				28										
Occupants type					Administration	on									
Ownership				Ring	Ringaarden Boligforening	orening									
Gross floor area (m <sup>2</sup> )					1446										
	Energy	۲.								Elect	Electricity			Water	ter
	Total T	Total/m²	Total heating	Domestic hot water	Heat losses	Space heating	Normalized space	Building operation	Vent.	Lighting	Cooling	Total	PV	Cold water	Hot wa ter
Monito-ring						1	heating	total				electricity			
Period		kWh/m <sup>2</sup>	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh			kWh	m³	m³
jan-19	10.867	00		0	0	16.891	10.867	- 0			1			7,7	0,0
feb-19	9:956	7	10.749	0		10.749	9.956	- 0					-	4,9	0,0
mar-19	9.337	9	5.773	42	0	5.731	9.295	- 0			-		-	7,5	0,8
apr-19	5.259	4					5.217	- 0					-	7,2	0,8
maj-19	748	1	5.773	42	0		706	- 0			-		-	7,5	0,8
jun-19	42	0	5.586	42	0	5.545	0	- 0					-	7,2	0,8
jul-19	42	0		42	0	5.731	0	- 0			-		-	7,5	0,8
aug-19	42	0			0		0	- 0		,				7,2	0,8
sep-19	1.486	1	4.820	105	472	4.244	579	331	0	331	0		820	13,2	2,0
okt-1 <mark>9</mark>	7.095	5	8.090	105	488	7.498	6.161	342	0	342	0		1.270	13,4	2,0
nov-19	8.578	9		105	472	8.317	6.666	1.336	488	331	517		353	12,8	2,0
dec-19	14.522	10	13.776	105	488	13.184	12.211	1.718	826	342	551		290	11,7	2,0
TOTAL	67.973	47	97.296	670	1.919	94.707	61.658	3.726	1.314	1.344	1.068		2.732	108	13
jan-20	11.920	8	10.005	105	488	9.413	10.045	1.284	510	342	432	5.354	367	14,1	2,0
feb-20	11.407	∞		105	440	9.605	9.671	1.191	449	309	434	5.009	685	12,7	2,0
mar-20	9.481	7	9.058	52	488	8.518	7.638	1.303	511	342	450	6.338	2.590	6,4	1,0
a pr-20	6.216	4			472	5.679	4.250	1.442	601	331	510		3.910	10,2	1,0
maj-20	2.635	2	4.140	105	488	3.548	601	1.442	628	342	472	3.890	4.540	11,2	2,0
jun-20	2.426	2		52	472	1.017	0	1.902	698	331	873	4.171	4.290	19,1	1,0
jul-20	2.796	2		52	488	3.105	0	2.257	1.013	342	902	5.122	3.660	6,4	1,0
aug-20	3.219	2		105	488	1.585	0	2.627	1.043	342	1.242		3.710	8,8	2,0
sep-20	2.827	2			472	2.827	446	1.857	847	331	679		2.430		1,0
okt-20	7.968	9		52	488	6.974		1.936	885	342	709		1.190	5,7	1,0
nov-20	10.125	7		52	472	8.677	7.832	1.770	803	331	636		556		1,0
dec-20	12.532	9	13.903	52	488	13.363	9.810	2.182	1.043	342	797	9.138	130	3,2	1,0
TOTAL	83.552	58	80.888	837	5.741	74.310	55.785	21.190	9.032	4.022	8.135	66.784	28.057	114	16
(Before)			kWh/m²	kWh/n	kWh/m²	kWh/m²	kWh/m								
2019	67.973	47,0		0,5		65,5	42,6	2,6							
2020	266.68	8,1c	<i>ч</i> ,сс		4,0										
mean 20	83.552	57,8	55,9	0,6	4,0	51,4	38,6	14,7							
			XXXXXX	Measured data	d data										
			XXXXXX	Calculated data	ed data										
			XXXXXXX	Measured data	d data										
		-	XXXXXXX	Calculated data	ed data										

# Dybedalen 1A (BEST DK-3) Dybedalen 1A. Aarhus

General Data		Dybedalen 1A, Aarhus
New RES	Photovoltaic system	
Year installed	2019	
Installation type	PV	
Address	Dybedalen A1	proved and the second sec
Installed panel capacity [kWp]	24.8	
Quantity [pieces]	75 panels	
Area [m²]	128.5	
Slope [°]	6°	
Orientation	48 panels SE and 42 panels S	
Est. annual prod. [kWh]	23,760 kWh	
Total Investment cost [€]	46,570€	

	Electricity		Climate		Performance		Electricity	
Period	Electricity produced	Normal year global radiation	Actual tilted irradiation on PV	Actual tilted irradiation on PV (calc)	Efficiency	Sold	Bought	Used from PV
	kWh	kWh/m²	kWh/m²	kWh	%	kWh	kWh	kWh
jan-19								
feb-19								
mar-19								
apr-19								
maj-19								
jun-19								
jul-19								
aug-19								
sep-19	820	83	83	10,729	8			
okt-19	1,270	44	46	5,943	21			
nov-19	353	19	10	1,343	26	0		353
dec-19	290	14	8	994	29	0		290
TOTAL	2,732	160	148	19,010	14	0	0	643
jan-20	367	19	13	1,709	21	0		367
feb-20	685	36	29	3,717	18	0		685
mar-20	2,590	83	89	11,462	23	0	4,678	2,590
apr-20	3,910	122	142	18,309	21	721	4,311	3,189
maj-20	4,540	148	180	23,092	20	930	3,890	3,610
jun-20	4,290	170	182	23,415	18	961	4,171	3,329
jul-20	3,660	161	145	18,677	20	1,282	5,122	2,378
aug-20	3,710	122	143	18,351	20	1,510	5,300	2,200
sep-20	2,430	83	92	11,850	21	454	5,524	1,976
okt-20	1,190	44	39	5,044	24	795	7,105	395
nov-20	556	19	18	2,365	23	0	6,959	556
dec-20	130	14	6	739	18	0	9,138	130
TOTAL	28,057	1,020	1,080	138,728	20	6,653	56,198	21,037

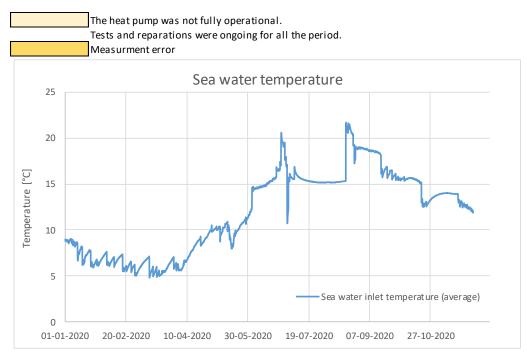
General Data						Hasle/Ske	DK4 Iby, Aarhus
Refurbished Building							,,
Year built	1968, extension in 2013					_	
Year refurbished	Jun-Nov 2016				-		Annal
Address	Hasle/Skelby						- Carlos
Building function	Residence	444	K			1	and the
Building type	Single family house		FALL				
Number of Apartments	-						
Number of Occupants	2 adults	4	a				
Gross Floor Area (m²)	174				4		· 84
Gross Volume (m³)	-						
Net Heated/Cooled Area (m²)	149						
Net Heated/Cooled Volume (m <sup>3</sup> )	-						
Basement Type	Dirt basement crawling sp	ace /in Da	nish: krybe	kælder)			
Attic Type	Low - only suited for limite	d storage					
Total Investment cost [Euro]	Approx. 18.000 €						
Ruilding Fosturos				mal (Befere	"Project"	Design (colo)	Actual
Building Features	Light structure i fraul - Co	141/21/	practice	-	Target	(calc)	("year")
External walls	Light structure + insulation	•		70	0.30	0.10	0.10
Roof	Additional attic insulation	4 ·		40	0.12	0.10	0.10
Ground floor	Wooden structure	W/m²K		75	-	-	-
Windows (frame & glass)	Aluminum/wood frame	W/m²K		90	0.80	0.70	0.90
Average U-value of glazings	-	W/m²K		-		0.80	0.70
Average g-value of glazings	-	-		-		0.50	-
Ventilation Flow Rate average	-	h⁻¹	0.3	-0.6		0.30	0.30
Thermal Bridges	-						
Air tightness & n50 air change rat	.e <u> </u>						
Ventilation system type	Natural ventilation						
Energy saving measures	Energy refurbishment and	replaceme	nt of white	goods			
Water saving measures	Тарѕ						
Special building materials	-						
Type of Shading	Curtains						
Energy Systems		Other in	formatio	on			
District Heating connection	yes						
Photovoltaic - grid connected	no	ĺ					
Solar thermal - flat plate	no						
Heat pump	no						
Boiler	no						
Kou Enorgy figures	1.) A/b /	Existing	BEST-	Deci	2017	2010	2040*
Key Energy figures	kWh/year/m <sup>2</sup> gross area	building	table	Design	2017	2018	2019*
Total Energy Demand		194.0	94.0	59.8	58.5	52.8	55.1
Total heat		155.0	79.0	56.5	55.8	50.0	51.9
Space heating		121.0	60.0	38.0	40.7	35.2	35.7
Domestic hot water		34.0	19.0	18.5	15.1	14.8	16.2
Pipe heat losses		Included	Included	Included	Included	Included	Included
Total electricity		39.0	15.0	3.3	2.8	2.8	3.2
Ventilation**		10.0	7.0	0.3	0.2	0.2	0.2
Lighting**		12.0	3.0	3.0	2.6	2.6	3.0
Other electricity**		17.0	5.0	0.0	0.0	0.0	0.0
Household electricity**		50.0	30.0	14.5	18.6	18.7	21.6
* = Not a full year.							
**The total electricity is shared as:							
**The total electricity is shared as: 1% Ventilation 12% Lighting							
**The total electricity is shared as: 1% Ventilation							
**The total electricity is shared as: 1% Ventilation 12% Lighting 87% Appliances							

					Dwelli	ng no. 1						
Address				Hasle/Skelb	y							
Typology o	of Dwelling			DK4								
Occupants	s number			2								
Occupants	s type			Family								
Ownership	D			Private								
Gross floo	or area (m²)			174								
	Ene	ergy						Elect	ricity		Wa	ter
	Total	Total/m²	Total heating	Hot water	Space heating	Space heating corrected	Total	Vent.	Lighting	Tenants	Cold water	Hot water
Monito-			nearing			(DTI)					water	water
ring											2	2
Period	kWh	kWh/m <sup>2</sup>	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	m³	m³
jan-17	1,988	11	1,950	225	1,725	1,434	330	3	40	287	-	-
feb-17	1,797	10	1,698	225	1,473	1,311	261	3	31	227	-	-
mar-17	1,672	10	1,495	225	1,270	1,162	285	3	34	248	-	-
apr-17 maj-17	1,032	6	1,002 472	225 225	777 247	480 45	327 328	3	39 39	284	-	-
jun-17	598 448	3	472 208	225	0	45	328 240	3	29	285 209	-	-
								2			-	
jul-17	492	3	207	207	0	0	285	3	34	248	-	-
aug-17	478	3	187	187	0	0	-	3	35	253	-	-
sep-17	538	3	411	225	186	0	313	3	38	272	-	-
okt-17	1,009	6	759	225	534	439	345	3	41	300	-	-
nov-17	1,407	8	1,336	225	1,111	841	341	3	41	297	-	-
dec-17	1,957	11	1,780	225	1,555	1,363	369	4	44	321	-	-
TOTAL	13,416	77	11,505	2,627	8,878	7,074	3,715	37	446	3,232	0	0
jan-18	1,950	11	1,859	225	1,634	1,358	367	4	44	319	-	-
feb-18	2,081	12	1,958	225	1,733	1,542	314	3	38	273	-	-
mar-18	1,735	10	1,960	225	1,735	1,184	326	3	39	284	-	-
apr-18	1,116	6	847	225	622	596	295	3	35	257	-	-
maj-18	490	3	249	225	24	0	265	3	32	231	-	-
jun-18	530	3	247	247	0	0		3	34	246	-	-
jul-18	445	3	194	194	0	0	-	3	30	218	-	-
aug-18	411	2	142	142	0	0		3	32	234	-	-
sep-18 okt-18	473 743	3	184 622	184 225	0 397	0 292	289 226	3	35 27	251 197	-	-
nov-18		4							42	307	-	-
	1,375		1,242	225	1,017	797	353	4			-	-
dec-18	1,087	6	1,462	225	1,237	357	505		61	439	-	- 0
TOTAL	12,436	71	10,966	2,567	8,399	6,126	3,743	37	449	3,256	0	0
jan-19 fob 10	1,960	11 9	1,778	225	1,553 996	1,340	395	4	47	344	-	-
feb-19	1,606	9	1,221	225 225	996	1,031	350 416	4	42 50	305 362	-	-
mar-19	1,546 1,091	9	1,190 812	225	965 587	905 538	328	4	39	285	-	-
apr-19 maj-19	572	3	467	225	242	37	328	3	39	285	_	_
jun-19	665	4	305	305	0	0	360		43	313	_	_
jul-19	617	4	257	257	0	0		4	43	313		
aug-19	585	4	257	257	57	0		4	43	313	_	_
sep-19	605	3	372	225	147	20	360	4	43	313	-	_
okt-19	1,099	5	851	225	626	514	360	4	43	313	_	_
nov-19	1,363	8	051	225	971	778	360	4	43	313	-	_
dec-19	1,505	ہ 9		225	1,139	1,055	360	4	43	313		_
jan-20	13,348	77	7,535	225 2,812	7,283	6,219	4,318	43	43 518	313	- 0	- 0
(Before)	13,340	11	7,535 kWh/m²		7,283 kWh/m²	kWh/m <sup>2</sup>	4,518 kWh/m²	43	518	3,730	0	0
2017	13,416	77	66.1	kwn/m <sup>-</sup> 15.1	51.0		,					
2017	12,436	71	63.0	14.8	48.3	35.2						
2018	12,430	71	43.3	14.8	48.3	35.2						
2019 mean 19	13,348 13,348	77	43.3 43	16.2	41.9 42		•		77			
meun 19	15,548		43	16	42	36	25		11			

## Sea water heat Pump 1 MW

		•
General Data		Hjortholmsvej 2A, Aarhus
New RES	Heat pump	
Year installed	2019	
Installation type	Seawater heat pump	
Address	Hjortholmsvej 2A	
Installed capacity [kW <sub>t</sub> ]	1000	
Quantity [pieces]	1	
Total Investment cost [€]	Confidential	

Monitoring Period	Heat produced	Cooling produced	Electricity consumed	COP, heating	COP, cooling	COP, combi.
	kWh	kWh	kWh	[-]	[-]	[-]
jan-20	16.140	8445	7.695	2,10	1,10	3,19
feb-20	24.610	13276	11.334	2,17	1,17	3,34
mar-20	10.450	6122	4.328	2,41	1,41	3,83
apr-20	61.900	44904	16.996	3,64	2,64	6,28
maj-20	32.770	-	2.069	15,84	0,00	15,84
jun-20	23.330	-	4.694	4,97	0,00	4,97
jul-20	240.370	-	5.671	42,39	0,00	42,39
aug-20	22240	13015	9225	2,41	1,41	3,82
sep-20	27180	17905	9275	2,93	1,93	4,86
okt-20	2.040	-	6.916	0,29	0,00	0,29
nov-20	Out of operation	-	5.246	n.a.	0,00	n.a.
dec-20	Repair					
TOTAL	461.030		83.450	5,52	0,00	5,52



	Ala	abastern, Vä	xjö		(BES	ST-catego	ry SE1)
General Data		, .			•	en and Hjalmar	· · ·
Refurbished Building					injuurub		1 64.15 742
Year built	1964-1966						
Year refurbished	2016-2018	A					
Address	Nydalavägen and Hjalmar		A.	+			
	Petris väg		Min 1	A			
Building function	Apartments				AA	74	
Building type	Renting buildings						File:
Number of Apartments	301				Sec. 1		
				Ar si fe			
Gross Floor Area (m <sup>2</sup> )	31,576						
Total Investment cost [Euro]	37,891,200		and the second second				Statement of the local division of the local
						I.	
Destadio e Frankruse					Project		Actual
Building Features				ictice/Before	target	Design (calc)	("year")
External walls	Additional insulation	W/m²K		.36	0.36	0.36	0.33
Roof	Additional attic insulation	W/m²K		.24	0.07	0.07	0.11
Ground floor	Partly renovated	W/m²K		.41	0.41	0.41	0.38
Windows (frame & glass)	-	W/m²K		.50	0.90	0.90	0.90
Average U-value of glazings	Aluminum/wood frame	W/m²K		.71	0.48	0.48	-
Average g-value of glazings	-	-		.76	0.46	0.46	-
Ventilation Flow Rate average	Mechanical ventilation	h⁻¹	0	.61	0.61	0.61	0.77
Thermal Bridges	-						
Air tightness & n50 air change ra							
Ventilation system type							
	Central aggregate for each						
Energy saving measures	Insulation, roof renovation	/apartments, new v			ſDH, automat	tion	
Energy saving measures Water saving measures		/apartments, new v			ſDH, automat	tion	
Energy saving measures Water saving measures Special building materials	Insulation, roof renovation Pipe insulations, new meter -	/apartments, new v rs, new taps			ſDH, a utomat	tion	
Energy saving measures Water saving measures	Insulation, roof renovation	/apartments, new v rs, new taps			ſDH, automat	tion	
Energy saving measures Water saving measures Special building materials	Insulation, roof renovation Pipe insulations, new meter -	/apartments, new v rs, new taps	ventilation system		ſDH, automat	ion	
Energy saving measures Water saving measures Special building materials Type of Shading	Insulation, roof renovation Pipe insulations, new meter -	/apartments, new v rs, new taps ngs	ventilation system		IDH, automat	tion	
Energy saving measures Water saving measures Special building materials Type of Shading Energy Systems	Insulation, roof renovation Pipe insulations, new meter - Curtains, building's overha	/apartments, new v rs, new taps ngs	ventilation system		IDH, automat	tion	
Energy saving measures Water saving measures Special building materials Type of Shading Energy Systems District Heating connection	Insulation, roof renovation Pipe insulations, new meter - Curtains, building's overha	/apartments, new v rs, new taps ngs	ventilation system	n, new windows, L <sup>1</sup> Result Total	IDH, automat	tion	
Energy saving measures Water saving measures Special building materials Type of Shading Energy Systems District Heating connection	Insulation, roof renovation Pipe insulations, new meter - Curtains, building's overha	/apartments, new v rs, new taps ngs Other informat	tion	n, new windows, Lī	IDH, automat	tion	
Energy saving measures Water saving measures Special building materials Type of Shading Energy Systems District Heating connection	Insulation, roof renovation Pipe insulations, new meter - Curtains, building's overha	/apartments, new v rs, new taps ngs Other information Existing building	tion Suggested	n, new windows, L <sup>1</sup> Result Total	IDH, automat	tion	
Energy saving measures Water saving measures Special building materials Type of Shading Energy Systems District Heating connection	Insulation, roof renovation Pipe insulations, new meter - Curtains, building's overha	/apartments, new v rs, new taps ngs Other informat	tion	n, new windows, L <sup>1</sup> Result Total energy delivered	IDH, a utoma1	tion	
Energy saving measures Water saving measures Special building materials Type of Shading Energy Systems District Heating connection	Insulation, roof renovation Pipe insulations, new meter - Curtains, building's overha	/apartments, new v rs, new taps ngs Other information Existing building	tion Suggested	n, new windows, L <sup>1</sup> Result Total energy delivered (kWh/m <sup>2</sup> )	IDH, automat	tion	
Energy saving measures Water saving measures Special building materials Type of Shading Energy Systems District Heating connection Photovoltaic - grid connected	Insulation, roof renovation Pipe insulations, new meter - Curtains, building's overha yes no	/apartments, new v rs, new taps ngs Other information Existing building	tion Suggested	n, new windows, L <sup>T</sup> Result Total energy delivered (kWh/m <sup>2</sup> ) Average 2018-	IDH, a utoma1	tion	
Energy saving measures Water saving measures Special building materials Type of Shading Energy Systems District Heating connection Photovoltaic - grid connected Key Energy figures District Heating kWh/m <sup>2</sup> yr (space)	Insulation, roof renovation Pipe insulations, new meter - Curtains, building's overha yes no	/apartments, new v rs, new taps ngs Other informa Existing building kWh/m <sup>2</sup> yr 149 0	tion Suggested specification	n, new windows, L <sup>T</sup> Result Total energy delivered (kWh/m <sup>2</sup> ) Average 2018- 2019	IDH, a utoma1	tion	
Energy saving measures Water saving measures Special building materials Type of Shading Energy Systems District Heating connection Photovoltaic - grid connected Key Energy figures District Heating kWh/m <sup>2</sup> yr (space)	Insulation, roof renovation Pipe insulations, new meter - Curtains, building's overha yes no	/apartments, new v rs, new taps ngs Other informat Existing building kWh/m <sup>2</sup> yr 149	tion Suggested specification	n, new windows, L <sup>1</sup> Result Total energy delivered (kWh/m <sup>2</sup> ) Average 2018- 2019 45	IDH, a utoma1	tion	

International and the control of the contro	(-The flag           (-The flag <th>Address</th> <th></th>	Address																
International and objects         In	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	ypology	of Dwelling					N <mark>y</mark> Multii	anily buildings									
Intermediate	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	)ccupants )ccupants	number type															
$ \begin{array}{                                    $	Joint function for the function function function for the function	)wnership																
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	iross flooi	r area (m <sup>2</sup> )						2031									
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		Energy						A	Aeasured Va	alues Heat				M easured Valu	tes Electricity	Measured Va	alues Wate
			Total	Total/m <sup>2</sup>	Tot delivered he			e at ing	Total delivered			DHW circulation	Space	Sp ace heating	T otal building	Total building		Hot water
		Monito-			mcl.losses(con			)	heat			losses	heating	(correct.)	elec	elec		
		ring																
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$		Period	kWh	kWh/m <sup>2</sup>	kWh/m <sup>2</sup>	kWh	kW	h	kWh		kWh/m <sup>2</sup>	kWh	kWh	kWh	kWh	kWh/m²	m <sup>3</sup>	m <sup>3</sup>
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	0.13         0         0.273         0.234         0.243         0.243         0.243         0.243         0.243         0.243         0.243         0.244         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.100         0.1	jan-18		12		11 22,550		28	22,522	3,468	2	663	16,010	16,038	1,218	1	146.97	59.8
1110         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         13         1	1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3         1.1.3 </td <td>feb-18</td> <td></td> <td>11</td> <td></td> <td></td> <td></td> <td>-2,763</td> <td>23,487</td> <td>3,459</td> <td>2</td> <td>622</td> <td>17,180</td> <td>14,417</td> <td></td> <td>1</td> <td>143.93</td> <td>59.64</td>	feb-18		11				-2,763	23,487	3,459	2	622	17,180	14,417		1	143.93	59.64
1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	mar-18		10				-3,647	23,626	4,142	2	682	16,050	12,403		1	171.27	71.42
418         906         4         56         4         800         530         2         630         130         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103	i = 10 $i = 10$	apr-18				7 13,632		-194	13,826	3,959	2	647	6,720	6,526		1	171.88	68.26
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$		maj-18		4		4 8,030		543	7,487	3,689	2	630	1,130	1,673		1	179.14	63.61
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$		jun-18		60		3 6,087		637	5,450	3,057	2	588	440	1,077	1,015	0	154.49	52.71
		jul-18		3		2 4,910		507	4,403	2,401	1	565	40	547	1,050	1	155.29	41.39
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$		aug-18		3		3 5,773		261	5,512	2,863	1	581	610	871	1,114	1	121.19	49.37
(i)         (i) <td>(i)         (i)         (i)<td>sep-18</td><td></td><td>4</td><td></td><td>4 7,568</td><td></td><td>-336</td><td>7,904</td><td>3,228</td><td>7</td><td>588</td><td>2,550</td><td>2,214</td><td></td><td>1</td><td>139.13</td><td>55.65</td></td>	(i)         (i) <td>sep-18</td> <td></td> <td>4</td> <td></td> <td>4 7,568</td> <td></td> <td>-336</td> <td>7,904</td> <td>3,228</td> <td>7</td> <td>588</td> <td>2,550</td> <td>2,214</td> <td></td> <td>1</td> <td>139.13</td> <td>55.65</td>	sep-18		4		4 7,568		-336	7,904	3,228	7	588	2,550	2,214		1	139.13	55.65
weak         17.866         1         10         11.20         10.00         11.124         11.124         11.124         1         11.86         1         136         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124         11.124 <td></td> <td>okt-18</td> <td>-</td> <td>9</td> <td></td> <td></td> <td></td> <td>-685</td> <td>12,601</td> <td>3,263</td> <td>2</td> <td>635</td> <td>6,950</td> <td>6,265</td> <td></td> <td>1</td> <td>140.65</td> <td>56.26</td>		okt-18	-	9				-685	12,601	3,263	2	635	6,950	6,265		1	140.65	56.26
ee/l         2.2.308         1         3/6         10         2.1.06         10         2.1.06         10         2.1.06         10         2.1.06         10         2.1.06         10         2.1.01         11.3.16         11         11.3.16         11         11.3.16         11         11.3.16         11         2.1.00         10.5.316         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11         2.1.3.16         11	ee/8         2.2.308         1         30.         10         2.10.6         10         2.10.6         10         2.10.6         10         2.10.6         10         2.10.6         10         2.10.6         10         2.10.6         10.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         1.2.20         <	nov-18		9		8 16,740		-513	17,253	3,448	2	629	11,120	10,607		1	148.6	59.44
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	dec-18		11				26	21,050	3,035	Ι	655	14,190	14,216		1	130.8	52.32
$ \begin{array}{                                    $		TOTAL		85				-6,136	165,121	40,012	20	3,779	92,990	86,854	13,471	7	1,803	069
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	jan-19		12		11 22,356		-1,511	23,867	6,257	3	670	16940	15,429	1,149	1	159.16	54.28
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	feb-19		10		10 20.047		1,454	18.593	5.270	ŝ	583	12740	14.194		0	159.16	50.38
		mar-19	_	10				229	19,031	5,865	ŝ	646	12520	12,749		1	159.16	57.81
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$		apr-19		1				-134	12,560	5,381	ŝ	609	6570	6,436		0	159.16	54.04
		maj-19		d)		4 8,882		-1,464	10,346	5,430	S	616	4300	2,836		1	162.85	57.28
	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	jun-19		60		3 5,615		365	5,250	4,565	2	565	120	485	066	0	163.39	51.96
	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	jul-19		<del>с</del> э		2 4,738		-71	4,809	3,879	2	570	360	289		1	150.19	43.56
	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	aug-19		с <b>л</b>		2 4,945		97	4,848	4,065	2	573	210	307	1,048	1	150.94	46.79
	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	sep-19		4				-663	8,257	4,708	2	559	2990	2,327	1,031	1	157.29	53.84
0v-10         17,316         0         006         8         16,529         -421         16,650         5,469         3         601         10,150         1,087         1         157.95         5         5         5         6         1,050         1,019         1,182         1         157.95         5         5         5         6         3         635         13,050         1,019         1,182         1         157.95         5         5         5         6         3         635         13,050         1,182         1         157.95         5         5         6         1,919         1,182         1         159.84         5           TTL         167,472         82         37%         7,226         87,450         85,373         12,645         6         1,909         7           T12456         85         78         7,226         87,450         85,373         12,645         6         1,909         7           T12456         85         78         7         21         21         21         7         21         21         1         1         1         1         1         1         1         1         1         1		okt-19						-928	13,302	5,633	ŝ	599	7070	6,142	1,094	1	169.79	61.76
ec-19         21,542         11         13%         10         20,360         969         19,391         5,706         3         53         13,050         14,019         1,182         1         15,934         5           TTL         167,472         82,37%         76         15,827         21,207         15,004         62,228         31         7,226         85,373         12,645         6         1,909           TTL         172,456         85         73         12,645         15         7         12         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1 <td>ec-19         21,542         11         13%         10         20,360         969         19,391         5,706         3         6.35         13,050         14,019         1,182         1         1           TAL         167,472         82         37%         76         15,470         31         7,226         87,450         85,373         12,645         6         7           Y BEST (kWhill)         106         149         21         21         21         21         21         21         21         7,226         87,450         85,373         12,645         6         7           Y BEST (kWhill)         172,456         85         7         7         21         21         21         7         12         7         1         1         7         7         1         1         7         7         1         1         7         7         1         1         7         7         1         7         7         1         1         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7</td> <td>nov-19</td> <td></td> <td>2</td> <td></td> <td></td> <td></td> <td>-421</td> <td>16,650</td> <td>5,469</td> <td>ŝ</td> <td>109</td> <td>10,580</td> <td>10,159</td> <td>1,087</td> <td>1</td> <td>157.95</td> <td>59.17</td>	ec-19         21,542         11         13%         10         20,360         969         19,391         5,706         3         6.35         13,050         14,019         1,182         1         1           TAL         167,472         82         37%         76         15,470         31         7,226         87,450         85,373         12,645         6         7           Y BEST (kWhill)         106         149         21         21         21         21         21         21         21         7,226         87,450         85,373         12,645         6         7           Y BEST (kWhill)         172,456         85         7         7         21         21         21         7         12         7         1         1         7         7         1         1         7         7         1         1         7         7         1         1         7         7         1         7         7         1         1         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7	nov-19		2				-421	16,650	5,469	ŝ	109	10,580	10,159	1,087	1	157.95	59.17
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	dec-19		11				696	19,391	5,706	ŝ	635	13,050	14,019	1,182	1	159.84	59.07
XP BFST (kWh/m2)     160     149     21     21     21     21 $172456$ 85     78     81     20     46 $167472$ 82     76     77     31     43 $ge 2019$ 82     76     77     31     43	DY BEST (kWh/m2)     160     149     21     21     21     21     1 $172,456$ 85     78     81     20     46 $167,472$ 82     76     77     31     43 $ge 2019$ 82     76     77     31     43	TOTAL		82			2	-2,077	156,904	62,228	31	7,226	87,450	85,373	12,645		1,909	650
172456         85         78         81         20         46           167,472         82         76         77         31         43           ge 2019         82         76         77         31         43	172,456         85         78         81         20         46           167,472         82         76         77         31         43           ge 2019         82         76         77         31         43	EADY B	EST (kWh/m2)	160		149			21	21			21					
167.472         82         76         77         31         43           ge 2019         82         76         77         31         43	167,472         82         76         77         31         43           ge 2019         82         76         77         31         43	018	172,456	85	2	78			81	20			46			7		
82 76 77 31 43	82 76 77 31 43	019	167,472	82	6	76			<i>LL</i>	31			43			9		
		erage 20.	61	82		76			77	31			43			6		

Alabastern area		NYD22, Växj	ö		(BE	ST-catego	ry SE1.1)
General Data						-	
Refurbished Building							
Year built	1964-1966						
Year refurbished	2018	-			1	Las	
Address	Nydalavägen 22	A CONTRACTOR				THE -	
Building function	apartments		- 11				
Building type	renting buildings	-				1 Sector	
Number of Apartments	36						
Gross Floor Area (m <sup>2</sup> )	3,361						
Total Investment cost [Euro]	4,361,516					T when	
Heat recovery system [Euro]	158,000						r -
PVT hybrid-system [Euro]	170,316						
					1		
Destable of Destables					Project		Actual
Building Features		14/1 21	Normal prac		target	Design (calc)	("year")
External walls	Additional insulation	W/m²K	0.3		0.36	0.36	0.33
Roof	Additional attic insulation	W/m²K	0.2		0.073	0.07	0.11
Ground floor	Partly renovated	W/m²K	0.4		0.413	0.41	0.38
Windows (frame & glass)	-	W/m²K	2.5		0.9	0.90	0.90
Average U-value of glazings	Aluminum/wood frame	W/m²K	0.7		0.475	0.48	-
Average g-value of glazings	-		0.7		0.46	0.46	-
Ventilation Flow Rate average	Mechanical ventilation	h <sup>-1</sup>	0.6	51	0.609	0.61	0.77
Thermal Bridges	-						
Air tightness & n50 air change ra							
Ventilation system type	Central aggregate located in						
Energy saving measures	Insulation, roof renovation/a		itilation system, r	new windows, L	ſDH, automati	on	
Water saving measures	Pipe insulations, new meters						
Special building materials	Waste water heat recovery w	ith heat pump, PVT	with heat pump a	nd BTES			
Type of Shading							
Energy Systems		Other informa	tion				
District Heating connection	yes	_					
Photovoltaic - grid connected	yes						
	BEST-Table SE1.1	Existing building	Suggested	Result 2020			
Key Energy figures		kWh/m <sup>2</sup> yr	specification	(kWh/m <sup>2</sup> )			
District Heating kWh/m <sup>2</sup> yr		149*	45	37	*DHW incl		
Domestic hot water kWh/m <sup>2</sup> yr		see above	21	19.1			
Electricity kWh/m <sup>2</sup> yr		11	8	15.1	incl elect to	heat pumps	
Heat from PVT kWh/m <sup>2</sup>		11			-		
			-22	-7	only seven m		
Electricity from PVT kWh/m <sup>2</sup>			-9	-2	only seven m	nonths	
Heat recovery from waste water			-8	-21	_		
TOTAL- supplied district heating	and building electricity	160	35	22			

***********************************	Image: constraint of the section of the sec	Energy        youm-agrication           Totalinti         Multifamily building           Reserved neut.         Tot delivered heut.         Tot delivered heut.         Multifamily building           Reserved neut.         Tot delivered heut.         Tot delivered heut.         Multifamily building           Rubini         RWhini         RWhini         RWhini         Multifamily building           Rubini         RWhini         RWhini         RWhini         RWhini         State           Acrosset(corr.)         incllosset(corr.)         incllosset(corr.)         DH-heat         on           Acrosset         S2310         S3         S3 <ths3< th="">         S3         S3</ths3<>					
Tends         Answer of the sectors in the sector in t	Total         Total         State         Attach         Attach <th>Total         Total         3361           Flergy         Mensured Values Heat.           Total         Total delivered heat.         Diff value Space           KWh         KWhin<sup>2</sup>         KWhin<sup>2</sup>         Mensured Values Heat.           KWh         KWhin<sup>2</sup>         KWhin<sup>2</sup>         KWh         Mensured Values Heat.           Sold         Total delivered heat.         Diff value Space         Mensured Values Heat.           KWh         KWhin<sup>2</sup>         KWhin<sup>3</sup>         KWhin<sup>4</sup>         KWh         Mensured Values Heat.           Sold         Total delivered heat.         Diff value Space         Sold         Sold         Sold           Sold         Total delivered heat.         KWh         KWh         KWhin<sup>4</sup>         KWhin<sup>4</sup>           Sold         Total delivered heat.         KWh         KWh         KWhin<sup>4</sup>         KWhin<sup>4</sup>           Sold         Total delivered heat.         KWh         KWhin<sup>4</sup>         KWhin<sup>4</sup>         KWhin<sup>4</sup>           Sold         Total delivered heat.         Total delivered heat.         Total delivered heat.         Total delivered heat.           Sold         Total delivered heat.         Sold         Total delivered heat.         KWhin<sup>4</sup>           Sold         Total delivered heat.</th> <th></th> <th></th> <th></th> <th></th> <th></th>	Total         Total         3361           Flergy         Mensured Values Heat.           Total         Total delivered heat.         Diff value Space           KWh         KWhin <sup>2</sup> KWhin <sup>2</sup> Mensured Values Heat.           KWh         KWhin <sup>2</sup> KWhin <sup>2</sup> KWh         Mensured Values Heat.           Sold         Total delivered heat.         Diff value Space         Mensured Values Heat.           KWh         KWhin <sup>2</sup> KWhin <sup>3</sup> KWhin <sup>4</sup> KWh         Mensured Values Heat.           Sold         Total delivered heat.         Diff value Space         Sold         Sold         Sold           Sold         Total delivered heat.         KWh         KWh         KWhin <sup>4</sup> KWhin <sup>4</sup> Sold         Total delivered heat.         KWh         KWh         KWhin <sup>4</sup> KWhin <sup>4</sup> Sold         Total delivered heat.         KWh         KWhin <sup>4</sup> KWhin <sup>4</sup> KWhin <sup>4</sup> Sold         Total delivered heat.         Total delivered heat.         Total delivered heat.         Total delivered heat.           Sold         Total delivered heat.         Sold         Total delivered heat.         KWhin <sup>4</sup> Sold         Total delivered heat.					
Intern         Statistic         S	Interfact the set of the set o	Energy         3461           Total         Total         3361           Total         Total         Measured Values Heat.           For delivered hear.         Diff value Space         Total delivered hear.         A measured Values Heat.           KWh         KWh         Measured Values Heat.           KWh         Measured Values Heat.           KWh         Measured Values Heat.           KWh         Measured Values Heat.           Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2"           Solut         Total delivered hear.         Measured Values Heat.           KWh         Memory White           KWh         Memory White           Solut         Total delivered hear.         Measured Values Heat.           Colspan="2"         Colad delivered hear.         Measured Values Heat.           Solut         Total delivered hear.         Measured Values Heat.           Colspan 20         Different Heat. <th></th> <th></th> <th></th> <th></th> <th></th>					
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Energy         isol           Total         Total delivered hear.         Total delivered hear.         isol           KWh         KWhm         KWhm         KWhm         MM         KWhm         MM         MM           KWh         KWhm         KWhm         KWhm         KWhm         KWhm         MM					
Trans         State         State <th< th=""><th>Total         Total         State         <th< th=""><th>Farety         3361           Farety         Measured Values Heat           Total         Tot derivered hear. Tot derivered hear. Tot derivered hear.         Measured Values Heat           Ew/h         KWh         KWh         KWh         KWh         KWh         KWh           29044         86         29.044         2.331         31.418         4.347         1.3           29044         86         29.044         2.331         31.418         4.347         1.3           25210         7.5         7.5         25.210         2.033         31.418         4.347         1.3           26,04         1.7         7.5         25.210         2.035         23.155         4.692         1.3           26,04         1.7         7.5         2.52.10         2.035         23.155         1.9           26,04         1.7         1.7         2.035         23.143         4.337         1.4           26,04         1.7         1.7         2.039         0.32         1.4         1.5           26,04         1.7         1.12         2.343         1.4         4.331         1.4           26,04         1.7         1.2</th><th></th><th></th><th></th><th></th><th></th></th<></th></th<>	Total         Total         State         State <th< th=""><th>Farety         3361           Farety         Measured Values Heat           Total         Tot derivered hear. Tot derivered hear. Tot derivered hear.         Measured Values Heat           Ew/h         KWh         KWh         KWh         KWh         KWh         KWh           29044         86         29.044         2.331         31.418         4.347         1.3           29044         86         29.044         2.331         31.418         4.347         1.3           25210         7.5         7.5         25.210         2.033         31.418         4.347         1.3           26,04         1.7         7.5         25.210         2.035         23.155         4.692         1.3           26,04         1.7         7.5         2.52.10         2.035         23.155         1.9           26,04         1.7         1.7         2.035         23.143         4.337         1.4           26,04         1.7         1.7         2.039         0.32         1.4         1.5           26,04         1.7         1.12         2.343         1.4         4.331         1.4           26,04         1.7         1.2</th><th></th><th></th><th></th><th></th><th></th></th<>	Farety         3361           Farety         Measured Values Heat           Total         Tot derivered hear. Tot derivered hear. Tot derivered hear.         Measured Values Heat           Ew/h         KWh         KWh         KWh         KWh         KWh         KWh           29044         86         29.044         2.331         31.418         4.347         1.3           29044         86         29.044         2.331         31.418         4.347         1.3           25210         7.5         7.5         25.210         2.033         31.418         4.347         1.3           26,04         1.7         7.5         25.210         2.035         23.155         4.692         1.3           26,04         1.7         7.5         2.52.10         2.035         23.155         1.9           26,04         1.7         1.7         2.035         23.143         4.337         1.4           26,04         1.7         1.7         2.039         0.32         1.4         1.5           26,04         1.7         1.12         2.343         1.4         4.331         1.4           26,04         1.7         1.2					
$ \begin{array}{                                    $	Integration         Monetory due and some partial fragments of the fragment o	Interget         Measured Values Heat           Totalins         Measured Values Heat           Totalins         Mean         DHW.           KWhm <sup>2</sup> KWhm <sup>2</sup> N         Mean         DHW.           KWhm <sup>2</sup> KWhm <sup>2</sup> N         KWh         N         N           KWhm <sup>2</sup> KWhm <sup>2</sup> KWhm <sup>2</sup> KWhm <sup>2</sup> N         KWhm <sup>2</sup> N           KWhm <sup>2</sup> KWhm <sup>2</sup> SO44         S.2         D319         S11/3         A.37         D1           A333         7.2 $24,333$ 319 $24,03$ $11,270$ $60,042$ $13$ A433         7.2 $24,333$ 319 $24,034$ $6,373$ $19$ A433         7.2 $24,333$ $319$ $24,034$ $6,042$ $16$ A44         1.5 $50,04$ $-2,333$ $319$ $5,019$ $6,042$ $16$ A44 $1.5$ $1.2,303$ $1.2,303$ $5,019$ $6,042$ $16$ A44 $1.2$ $1.2,303$ $5,014$ $2.1,161$ $2.1,161$					
Image: constraints         Transmissions         Transmissions         Transmissions         Seventiants         Seventiants         Seventiants         Contraining         Transmissions           Mathemacinentiar         Transmissions         Mathemacinentiar         Transmissions         Mathemacinentiar         Mathmacinentiar         Mathemacinentiar         M		Totalint <sup>2</sup> Tot delivered heat.         Tot delivered heat.         Diff value $\ensure \ensure \en$		M easured	Values Electricity	M easured V	alues Water
1         FWhite         KWhite	1         VM/m         V	kWhm <sup>2</sup> kWh         kW		ating Total build t.) elec	ling Total building elec		Hot water
0044         6.6         0.041         0.234         0.14.8         4.34         1.3         5.7         0.00         0         0           0.24.10         7.2         3.20.1         3.20.1         3.20.1         3.20.1         3.20.1         3.20.1         0.00         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0           0.00         0.1         0.10         0.10         0.10         0.10         0.10         0         0         0         0         0         0         0         0         0         0         0         0         0         0 <th0< th="">         0         <th0< th=""> <th0< th=""></th0<></th0<></th0<>	0.044         6.6         0.04         0.234         0.14         0.14         0.12         0.04         0.02         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0	8.6         8.6 $20,044$ $-2,374$ $31,418$ $4,347$ $1,3$ 7.5 $7.5$ $25,210$ $20,055$ $23,155$ $4,692$ $1,4$ 7.4 $4,4$ $14,839$ $-1180$ $15,019$ $6,042$ $1.8$ 7.4 $4,4$ $14,839$ $-1780$ $11,279$ $6,038$ $1.8$ 7.6 $5,074$ $-60$ $5,143$ $4,637$ $1.5$ 9.2 $1.5$ $5,074$ $-60$ $5,143$ $4,851$ $1.4$ 9.1 $2,720$ $5,074$ $-614$ $7,965$ $5,072$ $1.5$ $5,10$ $5,144$ $4,851$ $1,4$ $4,851$ $1.4$ $6,07$ $5,144$ $7,965$ $5,072$ $1.5$ $5,104$ $5,164$ $7,965$ $5,072$ $1.5$ $6,07$ $5,124$ $7,965$ $5,072$ $1.5$ $6,07$ $5,124$ $7,965$ $5,104$ $1.5$ $6,07$ <td></td> <td></td> <td>kWh/m<sup>2</sup></td> <td>m³</td> <td>m³</td>			kWh/m <sup>2</sup>	m³	m³
3.310         1         2         3.310         1         3.315         4.00         1.310         1.300         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0       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<math>1.5</math> <math>5.201</math> <math>5.035</math> <math>5.027</math> <math>1.8</math> <math>3.1</math> <math>2.72</math> <math>1.4.312</math> <math>-1.386</math> <math>15.68</math> <math>5.047</math> <math>1.4</math> <math>6.7</math> <math>6.1</math> <math>2.0,472</math> <math>-1.386</math> <math>5.688</math> <math>5.047</math> <math>1.5</math> <math>8.6</math> <math>5.077</math> <math>1.4312</math> <math>2.1.166</math> <math>5.439</math> <math>1.6</math> <math>6.7</math> <math>5.536</math> <math>5.023</math> <math>1.6</math> <math>5.463</math> <math>5.047</math> <math>1.4</math> <math>6.67</math></td><td>510</td><td>,236</td><td></td><td>164.23</td><td>74.94</td></td>	10         12         2210         2315         4102         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103         103 <td>7.5 <math>7.5</math> <math>2.3.210</math> <math>2.055</math> <math>2.3.155</math> <math>4.602</math> <math>1.4</math> <math>7.2</math> <math>7.2</math> <math>2.3.33</math> <math>319</math> <math>2.034</math> <math>6.375</math> <math>1.9</math> <math>7.4</math> <math>4.4</math> <math>4.839</math> <math>-1800</math> <math>1.5019</math> <math>6.042</math> <math>1.8</math> <math>1.7</math> <math>1.7</math> <math>5.626</math> <math>4.26</math> <math>5.200</math> <math>5.087</math> <math>1.8</math> <math>1.7</math> <math>1.7</math> <math>5.626</math> <math>4.26</math> <math>5.143</math> <math>6.375</math> <math>1.8</math> <math>1.7</math> <math>5.626</math> <math>4.26</math> <math>5.100</math> <math>5.087</math> <math>1.8</math> <math>2.1</math> <math>1.5</math> <math>5.201</math> <math>5.035</math> <math>5.027</math> <math>1.8</math> <math>3.1</math> <math>2.72</math> <math>1.4.312</math> <math>-1.386</math> <math>15.68</math> <math>5.047</math> <math>1.4</math> <math>6.7</math> <math>6.1</math> <math>2.0,472</math> <math>-1.386</math> <math>5.688</math> <math>5.047</math> <math>1.5</math> <math>8.6</math> <math>5.077</math> <math>1.4312</math> <math>2.1.166</math> <math>5.439</math> <math>1.6</math> <math>6.7</math> <math>5.536</math> <math>5.023</math> <math>1.6</math> <math>5.463</math> <math>5.047</math> <math>1.4</math> <math>6.67</math></td> <td>510</td> <td>,236</td> <td></td> <td>164.23</td> <td>74.94</td>	7.5 $7.5$ $2.3.210$ $2.055$ $2.3.155$ $4.602$ $1.4$ $7.2$ $7.2$ $2.3.33$ $319$ $2.034$ $6.375$ $1.9$ $7.4$ $4.4$ $4.839$ $-1800$ $1.5019$ $6.042$ $1.8$ $1.7$ $1.7$ $5.626$ $4.26$ $5.200$ $5.087$ $1.8$ $1.7$ $1.7$ $5.626$ $4.26$ $5.143$ $6.375$ $1.8$ $1.7$ $5.626$ $4.26$ $5.100$ $5.087$ $1.8$ $2.1$ $1.5$ $5.201$ $5.035$ $5.027$ $1.8$ $3.1$ $2.72$ $1.4.312$ $-1.386$ $15.68$ $5.047$ $1.4$ $6.7$ $6.1$ $2.0,472$ $-1.386$ $5.688$ $5.047$ $1.5$ $8.6$ $5.077$ $1.4312$ $2.1.166$ $5.439$ $1.6$ $6.7$ $5.536$ $5.023$ $1.6$ $5.463$ $5.047$ $1.4$ $6.67$	510	,236		164.23	74.94
12         12         3433         12         5434         643         169         643         169         17.06         0         0         0           4600         12         543         13         543         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         643         13.0         13.0         13.0         13.0         13.0         13.0         13.0         13.0         13.0         13.0         13.0         13.0	July         7.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1         0.1 <td>7.2 <math>7.2</math> <math>24.33</math> <math>319</math> <math>24,034</math> <math>6,375</math> <math>19</math> <math>4.4</math> <math>4.43</math> <math>-1.830</math> <math>-1.80</math> <math>15,019</math> <math>6,042</math> <math>18</math> <math>1.7</math> <math>1.7</math> <math>5,626</math> <math>-426</math> <math>5,200</math> <math>5,087</math> <math>1.5</math> <math>1.7</math> <math>1.7</math> <math>5,626</math> <math>-426</math> <math>5,200</math> <math>5,087</math> <math>1.5</math> <math>1.7</math> <math>5,674</math> <math>-693</math> <math>5,143</math> <math>4,851</math> <math>1.4</math> <math>1.7</math> <math>5,607</math> <math>-614</math> <math>7,86</math> <math>5,003</math> <math>1.5</math> <math>5,07</math> <math>5,074</math> <math>-1.386</math> <math>1,636</math> <math>5,003</math> <math>1.5</math> <math>5,07</math> <math>0.12</math> <math>2.716</math> <math>-1.386</math> <math>1,636</math> <math>5,007</math> <math>1.5</math> <math>6,042</math> <math>1.8</math> <math>2.6,077</math> <math>1.138</math> <math>2.6397</math> <math>1.5</math> <math>8.6</math> <math>7.8</math> <math>1.4312</math> <math>-1.386</math> <math>1.639</math> <math>5.047</math> <math>1.5</math> <math>8.6</math> <math>7.8</math> <math>1.639</math> <math>2.637</math> <math>2.639</math> <math>1.64</math> <math>8.6</math> <math>5.936</math> <math>1.639</math></td> <td></td> <td>,055</td> <td>0 0</td> <td>175.64</td> <td>80.9</td>	7.2 $7.2$ $24.33$ $319$ $24,034$ $6,375$ $19$ $4.4$ $4.43$ $-1.830$ $-1.80$ $15,019$ $6,042$ $18$ $1.7$ $1.7$ $5,626$ $-426$ $5,200$ $5,087$ $1.5$ $1.7$ $1.7$ $5,626$ $-426$ $5,200$ $5,087$ $1.5$ $1.7$ $5,674$ $-693$ $5,143$ $4,851$ $1.4$ $1.7$ $5,607$ $-614$ $7,86$ $5,003$ $1.5$ $5,07$ $5,074$ $-1.386$ $1,636$ $5,003$ $1.5$ $5,07$ $0.12$ $2.716$ $-1.386$ $1,636$ $5,007$ $1.5$ $6,042$ $1.8$ $2.6,077$ $1.138$ $2.6397$ $1.5$ $8.6$ $7.8$ $1.4312$ $-1.386$ $1.639$ $5.047$ $1.5$ $8.6$ $7.8$ $1.639$ $2.637$ $2.639$ $1.64$ $8.6$ $5.936$ $1.639$		,055	0 0	175.64	80.9
4480         44         44         44         44         44         44         44         44         45         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450         450	(48)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4)         (4) <td>4.4         4.4         14,839         <math>-180</math> <math>15,019</math> <math>6,042</math> <math>1.8</math> <math>1.279</math> <math>6,042</math> <math>1.8</math>           2.8         <math>2.8</math> <math>9,499</math> <math>-1.780</math> <math>1.1279</math> <math>6,038</math> <math>1.8</math>           1.7         <math>1.5</math> <math>1.5</math> <math>5,074</math> <math>2.8</math> <math>9,485</math> <math>1.4</math> <math>1.5</math>           1.5         <math>1.5</math> <math>5,074</math> <math>-69</math> <math>5,143</math> <math>4,851</math> <math>1.4</math>           2.1         <math>2.5</math> <math>1.6</math> <math>5,348</math> <math>1.536</math> <math>5,003</math> <math>1.5</math>           3.1         <math>2.2</math> <math>1.4,312</math> <math>-1.386</math> <math>1.5,688</math> <math>5,104</math> <math>1.5</math>           6.0         <math>8.6</math> <math>7.8</math> <math>2.0,472</math> <math>-1.386</math> <math>1.6,988</math> <math>1.9</math>           8.6         <math>7.8</math> <math>2.7,427</math> <math>1.364</math> <math>2.1,116</math> <math>4.781</math> <math>1.4</math>           8.6         <math>7.8</math> <math>2.7,427</math> <math>1.32</math> <math>2.6,439</math> <math>1.6</math>           9.0         <math>8.6</math> <math>2.7,427</math> <math>3.371</math> <math>2.3,633</math> <math>1.6</math>           9.0         <math>8.8</math> <math>2.7,427</math> <math>2.3,635</math> <math>6,108</math>&lt;</td> <td></td> <td>,709</td> <td>0 0</td> <td>221.87</td> <td>109.91</td>	4.4         4.4         14,839 $-180$ $15,019$ $6,042$ $1.8$ $1.279$ $6,042$ $1.8$ 2.8 $2.8$ $9,499$ $-1.780$ $1.1279$ $6,038$ $1.8$ 1.7 $1.5$ $1.5$ $5,074$ $2.8$ $9,485$ $1.4$ $1.5$ 1.5 $1.5$ $5,074$ $-69$ $5,143$ $4,851$ $1.4$ 2.1 $2.5$ $1.6$ $5,348$ $1.536$ $5,003$ $1.5$ 3.1 $2.2$ $1.4,312$ $-1.386$ $1.5,688$ $5,104$ $1.5$ 6.0 $8.6$ $7.8$ $2.0,472$ $-1.386$ $1.6,988$ $1.9$ 8.6 $7.8$ $2.7,427$ $1.364$ $2.1,116$ $4.781$ $1.4$ 8.6 $7.8$ $2.7,427$ $1.32$ $2.6,439$ $1.6$ 9.0 $8.6$ $2.7,427$ $3.371$ $2.3,633$ $1.6$ 9.0 $8.8$ $2.7,427$ $2.3,635$ $6,108$ <		,709	0 0	221.87	109.91
9,00         23         9,00         173         0,00         173         0,00         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0	9.00         2.8         0.9.0         1.12%         1.12%         1.12%         0.0         1.12%         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0	2.8 $2.8$ $2.8$ $9.499$ $-1,780$ $11,279$ $6,038$ $1.8$ 1.7 $1.7$ $5,026$ $426$ $5,143$ $4,851$ $1.4$ 9.2 $1.5$ $5,074$ $-69$ $5,143$ $4,851$ $1.4$ 9.2 $1.5$ $5,074$ $-69$ $5,143$ $4,851$ $1.4$ 9.2 $1.5$ $5,074$ $-69$ $5,143$ $4,851$ $1.4$ 9.2 $1.5$ $5,072$ $1.5$ $5,072$ $1.5$ $1.4$ $6.6$ $5,143$ $1.632$ $5,072$ $1.5$ $1.6$ $6.6$ $5,143$ $2.162$ $2.444$ $2.1,116$ $4,781$ $1.4$ $6.6$ $5,144$ $2.1,116$ $4,781$ $1.4$ $1.5$ $6.6$ $5,134$ $2.1,116$ $4,781$ $1.4$ $1.6$ $6.6$ $5,134$ $2.1,116$ $2.1,33$ $5,261$ $1.6$ $7.1$ $8.1,33$		;,630			104.18
6.60         17         12         5.60         13         5.20         5.00         5.01         5.00         5.00         5.00         5.00         5.00         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0      <	56.6         17         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0.3         5.0	1.7 $1.7$ $5.626$ $426$ $5.200$ $5.037$ $1.5$ 9.2 $1.5$ $5.074$ $-69$ $5.143$ $4.851$ $1.4$ 9.2 $1.5$ $5.074$ $-69$ $5.143$ $4.851$ $1.4$ 9.2 $1.5$ $5.074$ $5.03$ $5.03$ $1.5$ $3.1$ $2.2$ $7.291$ $-6744$ $7.965$ $5.072$ $1.5$ $5.0$ $6.1$ $2.2$ $7.291$ $-6744$ $2.047$ $1.5$ $6.7$ $5.7$ $1.87145$ $-2.1138$ $1.5698$ $5.104$ $1.5$ $6.7$ $5.7$ $1.87145$ $-2.1716$ $4.781$ $1.4$ $6.67$ $5.7$ $1.87145$ $-2.1716$ $4.781$ $1.5$ $6.7$ $5.938$ $5.104$ $1.5$ $5.947$ $1.5$ $6.67$ $5.316$ $1.66$ $2.7433$ $6.486$ $1.9$ $7.1$ $6.168$ $8.8533$ $4.969$		,450			104.1
600         15         5014         16         5014         16         5014         601         17         530         131         601         101         531         131         510         530         131         631         131         631         131         631         131         631         131         631         131         631         131         631         131         631         131         631         131         631         131         631         131         631         131         631         131         631         131         631         131         631         131         631         131         631         131         131         131         231         131         231         131         231         131         231         131         231         131         231         131         231         131         231         131         231         131         231         131         231         131         231         131         231         131         231         131         131         131         131         131         131         131         131         131         131         131         131         131         131 <td>600         15         504         15         504         15         504         15         504         16         314         18         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         &lt;</td> <td>1.5         <math>1.5</math> <math>5.074</math> <math>-603</math> <math>5.143</math> <math>4.851</math> <math>1.4</math>           9.2         <math>1.6</math> <math>5.348</math> <math>153</math> <math>5.195</math> <math>5.003</math> <math>1.5</math>           3.1         <math>2.2</math> <math>1.291</math> <math>-674</math> <math>1.63</math> <math>5.072</math> <math>1.5</math> <math>5.0</math> <math>4.3</math> <math>14.312</math> <math>-1.386</math> <math>15.698</math> <math>5.104</math> <math>1.5</math> <math>6.0</math> <math>5.1</math> <math>14.312</math> <math>-1.386</math> <math>15.698</math> <math>5.072</math> <math>1.5</math> <math>6.0</math> <math>5.1</math> <math>14.312</math> <math>-1.386</math> <math>15.698</math> <math>5.104</math> <math>1.5</math> <math>6.0</math> <math>5.3</math> <math>18.1445</math> <math>-2.1386</math> <math>2.6432</math> <math>1.4</math> <math>6.0</math> <math>5.3</math> <math>18.145</math> <math>21.166</math> <math>4.781</math> <math>1.6</math> <math>7.1</math> <math>6.188</math> <math>21.612</math> <math>2.433</math> <math>2.691</math> <math>1.6</math> <math>7.1</math> <math>6.18833</math> <math>6.486</math> <math>1.9</math> <math>5.934</math> <math>1.6</math> <math>7.1</math> <math>1.8234</math> <math>6.168</math> <math>1.8</math> <math>5.934</math> <math>1.6</math> <math>7.10</math> <math>0.2</math> <math>2.2483</math></td> <td></td> <td>566</td> <td>0 0</td> <td>208.95</td> <td>87.7</td>	600         15         504         15         504         15         504         15         504         16         314         18         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         30         <	1.5 $1.5$ $5.074$ $-603$ $5.143$ $4.851$ $1.4$ 9.2 $1.6$ $5.348$ $153$ $5.195$ $5.003$ $1.5$ 3.1 $2.2$ $1.291$ $-674$ $1.63$ $5.072$ $1.5$ $5.0$ $4.3$ $14.312$ $-1.386$ $15.698$ $5.104$ $1.5$ $6.0$ $5.1$ $14.312$ $-1.386$ $15.698$ $5.072$ $1.5$ $6.0$ $5.1$ $14.312$ $-1.386$ $15.698$ $5.104$ $1.5$ $6.0$ $5.3$ $18.1445$ $-2.1386$ $2.6432$ $1.4$ $6.0$ $5.3$ $18.145$ $21.166$ $4.781$ $1.6$ $7.1$ $6.188$ $21.612$ $2.433$ $2.691$ $1.6$ $7.1$ $6.18833$ $6.486$ $1.9$ $5.934$ $1.6$ $7.1$ $1.8234$ $6.168$ $1.8$ $5.934$ $1.6$ $7.10$ $0.2$ $2.2483$		566	0 0	208.95	87.7
0.0%         0.1         0.5,4%         1/0         5,1%         5,0%         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1/0         1	0.006         0.1         1.0         5.4.4         1.0         5.4.4         1.0         5.4.4         1.0         2.4.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         1.0         2.5.0.0         2.5.0.0         2.5.0	9.2 $1.6$ $5.348$ $153$ $5.195$ $5.003$ $1.5$ 3.1 $2.2$ $7.291$ $-674$ $7.965$ $5.072$ $1.5$ 5.0 $6.1$ $2.2$ $7.291$ $-674$ $7.965$ $5.072$ $1.5$ 6.0 $6.1$ $20.472$ $-1.386$ $5.047$ $1.5$ 6.1 $20.472$ $-1.386$ $21.116$ $4.781$ $1.4$ 6.0 $7.8$ $26.077$ $1.4312$ $-2.716$ $2.443$ $1.4$ 6.1 $20.367$ $1.87.145$ $-2.413$ $23.653$ $5.261$ $1.6$ 7.1 $6.1$ $20.367$ $1.314$ $8.853$ $6.486$ $1.9$ 7.1 $6.1$ $20.367$ $1.314$ $8.853$ $6.486$ $1.9$ 7.1 $6.1$ $20.367$ $1.514$ $8.853$ $6.486$ $1.9$ $7.10$ $6.1$ $8.853$ $4.965$ $5.993$ $1.7$ $2.1$ <td>350</td> <td>281</td> <td>0</td> <td>198.58</td> <td>83.63</td>	350	281	0	198.58	83.63
(10.7)         31         22         7291         644         7.06         5.07         1.5         5.93         3.000         2.366         2.988         0.0           (10.0)         6         1         0.413         1.600         5.001         1.500         5.001         1.10         0.001         2.369         0.01         0.114         2.568         0.0           2061         8.6         7.0         7.10         5.007         1.438         2.4699         5.017         1.5         6.33         1.01         0.00         0.114         2.964         0.0           24.00         8.7         7.145         3.743         2.469         5.01         1.5         6.33         1.03         0.11         0.114         0.0         0.114         0.0         0.114         0.0         0.114         0.0         0.114         0.0         0.114         0.114         0.114         0.13         0.114         0.114         0.114         0.114         0.114         0.114         0.114         0.114         0.114         0.114         0.114         0.114         0.114         0.114         0.114         0.114         0.114         0.114         0.114         0.114         0.114 <th< td=""><td>(10.7)         31         22         7.291         6/3         7.66         5.072         1.5         5.93         3.040         2.366         2.368         0.0           (10.8)         6         1         0.11         1.6         7.608         5.071         1.6         7.608         5.071         1.6         7.803         5.071         1.6         7.803         5.071         1.6         7.803         5.071         1.6         7.803         5.071         1.6         7.803         5.071         1.6         7.803         5.071         1.6         7.803         2.9         0.0         1.6         0.0         1.6         0.0         1.6         0.0         1.6         0.0         1.6         0.0         1.6         0.0         1.6         0.0         1.6         0.0         1.6         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0&lt;</td><td>3.1         <math>2.2</math> <math>7.291</math> <math>-674</math> <math>7.965</math> <math>5.072</math> <math>1.5</math>           5.0         <math>4.3</math> <math>14.312</math> <math>-1.386</math> <math>15.698</math> <math>5.104</math> <math>1.5</math>           6.0         6.1         <math>20.472</math> <math>-644</math> <math>21.116</math> <math>4.781</math> <math>1.4</math>           6.0         <math>6.1</math> <math>20.472</math> <math>-644</math> <math>21.116</math> <math>4.781</math> <math>1.4</math>           6.0         <math>5.3</math> <math>187.145</math> <math>-2.716</math> <math>18.363</math> <math>5.047</math> <math>1.5</math>           9.0         <math>8.2</math> <math>27.427</math> <math>3.774</math> <math>23.653</math> <math>5.261</math> <math>1.6</math>           7.1         <math>6.1</math> <math>8.2</math> <math>27.427</math> <math>3.774</math> <math>23.653</math> <math>5.261</math> <math>1.6</math>           7.1         <math>6.1</math> <math>8.334</math> <math>6.1833</math> <math>4.866</math> <math>1.9</math> <math>5.933</math> <math>1.66</math>           3.4         <math>2.1</math> <math>6.163</math> <math>2.34</math> <math>5.013</math> <math>1.5</math> <math>2.0</math> <math>0.15</math> <math>1.612</math> <math>-2.483</math> <math>4.065</math> <math>5.933</math> <math>1.6</math> <math>3.4</math> <math>0.1</math> <math>8.8334</math> <math>4.085</math> <math>5.013</math> <math>1.5</math></td><td>330</td><td></td><td></td><td></td><td>86.26</td></th<>	(10.7)         31         22         7.291         6/3         7.66         5.072         1.5         5.93         3.040         2.366         2.368         0.0           (10.8)         6         1         0.11         1.6         7.608         5.071         1.6         7.608         5.071         1.6         7.803         5.071         1.6         7.803         5.071         1.6         7.803         5.071         1.6         7.803         5.071         1.6         7.803         5.071         1.6         7.803         5.071         1.6         7.803         2.9         0.0         1.6         0.0         1.6         0.0         1.6         0.0         1.6         0.0         1.6         0.0         1.6         0.0         1.6         0.0         1.6         0.0         1.6         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0<	3.1 $2.2$ $7.291$ $-674$ $7.965$ $5.072$ $1.5$ 5.0 $4.3$ $14.312$ $-1.386$ $15.698$ $5.104$ $1.5$ 6.0         6.1 $20.472$ $-644$ $21.116$ $4.781$ $1.4$ 6.0 $6.1$ $20.472$ $-644$ $21.116$ $4.781$ $1.4$ 6.0 $5.3$ $187.145$ $-2.716$ $18.363$ $5.047$ $1.5$ 9.0 $8.2$ $27.427$ $3.774$ $23.653$ $5.261$ $1.6$ 7.1 $6.1$ $8.2$ $27.427$ $3.774$ $23.653$ $5.261$ $1.6$ 7.1 $6.1$ $8.334$ $6.1833$ $4.866$ $1.9$ $5.933$ $1.66$ 3.4 $2.1$ $6.163$ $2.34$ $5.013$ $1.5$ $2.0$ $0.15$ $1.612$ $-2.483$ $4.065$ $5.933$ $1.6$ $3.4$ $0.1$ $8.8334$ $4.085$ $5.013$ $1.5$	330				86.26
(6)00         50         42         14.312         1.380         15,042         6.13         17,360         9.17         2.448         0.01         16,500         9.174         2.448         0.01         16,500         9.174         2.448         0.01         16,500         2.448         0.01         16,500         2.448         0.01         16,500         2.439         0.01         16,500         2.974         0.01         16,500         2.974         0.01         16,500         2.974         0.01         16,500         2.974         0.01         16,500         2.974         0.01         16,500         2.974         0.01         16,500         2.974         0.01         16,500         2.974         0.01         16,500         2.974         0.01         16,500         2.974         0.01         16,500         2.974         0.01         16,500         2.974         0.01         16,500         2.974         0.01         16,500         2.974         0.01         16,500         2.974         0.01         16,500         2.946         2.946         2.946         2.946         2.946         2.946         2.946         2.946         2.946         2.946         2.946         2.946         2.946         2.946         2.94	(6)0         50         4.2         (4.3)         (5.08)         5.04         (5.08)         5.04         (5.06)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)         (5.07)	5.0         4.3         14,312 $-1.386$ 15,698         5,104         15           6.9         6.1         20,472 $-644$ 21,116         4,781         14           8.6         7.8         56,077         18,348         24,639         5,047         15           9.0         8.1         55.7         187,145 $-27,16$ 189,861         62,439         19           9.0         8.2         27,427         3,774         23,653         5,261         16           7.1         6.1         20,367         1,514         18,833         6,486         19           7.1         6.1         8.1         18,234         6,486         19           3.4         2.1         18,833         4085         5,013         15           2.0         0.1         2.28         -34         5,013         15           2.0         0.1         2.28         -34         5,013         15           2.0         0.1         2.28         2.34         5,013         15           2.0         0.1         2.28         2.34         5,013         15           2.0         0.1         3.36 <td></td> <td></td> <td></td> <td></td> <td>87.45</td>					87.45
3.3.01         6.9         6.1         2.0.72         6.44         2.1.16         4.78         1.4         6.01         1.6.36         2.8.29         0.8           20.061         8.8         5.6077         7.143         2.6.607         7.8         2.6.607         1.6.18         2.7.63         2.9.69         0.8           20.061         8.5         7.8         2.6.077         7.143         2.6.607         1.6.18         2.7.69         0.8         1.6         2.7.9         0.9         0.8         0.9         2.9.0         0.9         0.9           20.843         7.1         6.1         2.7.4         2.7.63         5.2.61         1.0         6.59         1.8190         2.1.64         2.9.90         0.9           20.843         7.1         6.1         2.7.63         5.2.61         1.0         6.59         1.8190         2.1.64         2.990         0.9           23.83         1.6         6.460         1.9         5.74         5.807         1.6         4.905         1.1         1.6           34.83         1.1         8.88         1.6         6.460         1.9         5.74         9.90         5.74         9.90         5.74         9.90 <td< td=""><td>3.3.01         6.0         0.4         20.472         6.44         21.16         4.781         14         6.01         15.36         2.829         0.8           3.3.01         6.67         5.077         1.318         3.469         5.047         1.336         2.4599         5.33         1.9368         2.939         0.8           3.3.01         6.7         5.7         1.318         2.4659         5.047         1.353         2.936         2.936         1.9         1.9           3.3.01         6.7         5.7         1.314         1.853         5.261         1.6         6.3         1.9368         2.936         1.9         1.9           3.3.3         71         6.1         5.361         1.6         6.3         1.8199         2.166         1.9           3.3.3         71         6.1         5.361         1.4         5.363         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.6         5.393</td><td>6.9         6.1         <math>20,472</math> <math>-644</math> <math>21,116</math> <math>4,781</math> <math>1,4</math>           8.6         <math>7.8</math> <math>26,077</math> <math>1,438</math> <math>24,639</math> <math>5,047</math> <math>1.5</math>           9.0         <math>8.2</math> <math>55.7</math> <math>187,145</math> <math>-27,16</math> <math>189,861</math> <math>62,439</math> <math>19</math>           9.0         <math>8.2</math> <math>27,427</math> <math>3.774</math> <math>23,653</math> <math>5.261</math> <math>1.6</math>           7.1         <math>6.1</math> <math>20,367</math> <math>1.514</math> <math>23,653</math> <math>5.261</math> <math>1.6</math>           9.0         <math>8.2</math> <math>27,427</math> <math>3.774</math> <math>23,653</math> <math>5.261</math> <math>1.6</math>           7.1         <math>6.1</math> <math>6.1</math> <math>8.83</math> <math>4.865</math> <math>1.9</math> <math>4.865</math> <math>1.9</math> <math>2.0</math> <math>0.1</math> <math>2.28</math> <math>-3.483</math> <math>4.965</math> <math>5.934</math> <math>1.6</math> <math>2.0</math> <math>0.1</math> <math>2.28</math> <math>-3.88</math> <math>616</math> <math>5.336</math> <math>1.6</math> <math>2.0</math> <math>0.1</math> <math>2.28</math> <math>2.34</math> <math>5.013</math> <math>1.7</math> <math>2.0</math> <math>0.1</math> <math>2.5336</math> <math>1.6</math> <math>5.336</math> <math>1.6</math></td><td></td><td></td><td></td><td></td><td>88</td></td<>	3.3.01         6.0         0.4         20.472         6.44         21.16         4.781         14         6.01         15.36         2.829         0.8           3.3.01         6.67         5.077         1.318         3.469         5.047         1.336         2.4599         5.33         1.9368         2.939         0.8           3.3.01         6.7         5.7         1.318         2.4659         5.047         1.353         2.936         2.936         1.9         1.9           3.3.01         6.7         5.7         1.314         1.853         5.261         1.6         6.3         1.9368         2.936         1.9         1.9           3.3.3         71         6.1         5.361         1.6         6.3         1.8199         2.166         1.9           3.3.3         71         6.1         5.361         1.4         5.363         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.393         1.6         5.6         5.393	6.9         6.1 $20,472$ $-644$ $21,116$ $4,781$ $1,4$ 8.6 $7.8$ $26,077$ $1,438$ $24,639$ $5,047$ $1.5$ 9.0 $8.2$ $55.7$ $187,145$ $-27,16$ $189,861$ $62,439$ $19$ 9.0 $8.2$ $27,427$ $3.774$ $23,653$ $5.261$ $1.6$ 7.1 $6.1$ $20,367$ $1.514$ $23,653$ $5.261$ $1.6$ 9.0 $8.2$ $27,427$ $3.774$ $23,653$ $5.261$ $1.6$ 7.1 $6.1$ $6.1$ $8.83$ $4.865$ $1.9$ $4.865$ $1.9$ $2.0$ $0.1$ $2.28$ $-3.483$ $4.965$ $5.934$ $1.6$ $2.0$ $0.1$ $2.28$ $-3.88$ $616$ $5.336$ $1.6$ $2.0$ $0.1$ $2.28$ $2.34$ $5.013$ $1.7$ $2.0$ $0.1$ $2.5336$ $1.6$ $5.336$ $1.6$					88
3061         86         78         3.007         1,438         2.4.03         3.047         15         6.33         19.300         2.036         2.036         0.00         2.036         0.00         0.01         0.00         0.01         0.00         0.01         0.00         0.01         0.00         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01	20.61         8.6         7.8 $2.6.07$ 1.438 $2.463$ $5.07$ $11.334$ $2.033$ $2.013$ $2.974$ $0.01$ 3.3.37         9.0         6.7         5.5 $18.744$ $2.363$ $2.363$ $2.363$ $2.974$ $2.039$ $100$ 3.3.37         9.0         6.1 $5.5$ $17.863$ $2.363$ $2.363$ $2.369$ $100$ $2.363$ $100$ $2.363$ $100$ $2.363$ $100$ $2.363$ $100$ $2.360$ $100$ $100$ $100$ $100$ $100$ $100$ $2.363$ $1.600$ $1.3346$ $2.360$ $1.61$ $2.360$ $1.390$ $2.360$ $1.390$ $1.390$ $1.390$ $1.390$ $1.390$ $1.390$ $1.300$ $1.336$ $1.300$ $1.300$ $1.300$ $1.300$ $1.300$ $1.300$ $1.300$ $1.300$ $1.300$ $1.300$ $1.300$ $1.300$ $1.300$ $1.300$ $1.300$ $1.300$ $1.300$ $1.300$ $1.300$	8.6 $7.8$ $26.077$ $1.438$ $24.639$ $5.047$ $1.5$ 66.7         55.7 $187,145$ $-2.716$ $189,861$ $62.439$ $19$ 9.0         8.2 $27,427$ $3.774$ $23,653$ $5.261$ $1.6$ 7.1         6.1 $5.3$ $17,863$ $-3714$ $23,653$ $5.261$ $1.6$ 7.1         6.1 $5.3$ $17,863$ $-3714$ $18,853$ $4.869$ $1.4$ $3.4$ $2.1$ $6.163$ $8.853$ $6.168$ $1.8$ $3.4$ $2.3$ $17,863$ $5.794$ $6.168$ $1.8$ $2.0$ $0.5$ $1.612$ $-2.483$ $4.095$ $5.693$ $1.7$ $2.0$ $0.1$ $2.2483$ $4.095$ $5.033$ $1.7$ $2.0$ $0.1$ $8.334$ $6.168$ $1.8$ $1.7$ $2.0$ $0.1$ $2.344$ $5.013$ $1.5$ $2.0$ $0.1$ $2.34$					82.43
4.2.04         6.67         55.7         187.146         2.7.16         189.66         2.7.40         27.16         189.66         27.16         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         17.3.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60         18.60 </td <td>4.204         66.7         55.7         187.145         -2.716         189.81         2.439         19         7,098         136,020         13.736         31,059         106         2.900         0.9         1           30.347         9.0         8.2         <math>27.427</math> <math>3.5734</math> <math>5.663</math> <math>1.4</math> <math>29.66</math> <math>2.900</math> <math>2.900</math> <math>0.9</math> <math>2.900</math> <math>2.900</math></td> <td>66.7 <math>55.7</math> <math>187,145</math> <math>-2,716</math> <math>189,861</math> <math>02,439</math> <math>19</math>           9.0         <math>8.2</math> <math>27,427</math> <math>3,774</math> <math>23,653</math> <math>5,261</math> <math>1.6</math>           7.1         <math>6.1</math> <math>5.3</math> <math>17,863</math> <math>-3714</math> <math>23,653</math> <math>5,261</math> <math>1.6</math>           7.1         <math>6.1</math> <math>5.3</math> <math>17,863</math> <math>-3714</math> <math>23,653</math> <math>5,261</math> <math>1.6</math>           3.4         <math>2.1</math> <math>6.1</math> <math>5.3</math> <math>5,164</math> <math>1.6</math> <math>1.4</math> <math>3.4</math> <math>2.1</math> <math>6.947</math> <math>-2.1483</math> <math>-3714</math> <math>8,853</math> <math>4,869</math> <math>1.7</math> <math>2.0</math> <math>0.5</math> <math>1.612</math> <math>-2.483</math> <math>4.095</math> <math>5,693</math> <math>1.7</math> <math>2.0</math> <math>0.1</math> <math>2.28</math> <math>-3.38</math> <math>616</math> <math>5,335</math> <math>1.7</math> <math>2.0</math> <math>0.1</math> <math>2.28</math> <math>-3.38</math> <math>616</math> <math>5,334</math> <math>1.6</math> <math>2.0</math> <math>0.1</math> <math>2.28</math> <math>-3.38</math> <math>616</math> <math>5,334</math> <math>1.6</math> <math>2.0</math> <math>0.1</math> <math>2.334</math> <math>1.602</math></td> <td></td> <td></td> <td></td> <td></td> <td>87.01</td>	4.204         66.7         55.7         187.145         -2.716         189.81         2.439         19         7,098         136,020         13.736         31,059         106         2.900         0.9         1           30.347         9.0         8.2 $27.427$ $3.5734$ $5.663$ $1.4$ $29.66$ $2.900$ $2.900$ $0.9$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$ $2.900$	66.7 $55.7$ $187,145$ $-2,716$ $189,861$ $02,439$ $19$ 9.0 $8.2$ $27,427$ $3,774$ $23,653$ $5,261$ $1.6$ 7.1 $6.1$ $5.3$ $17,863$ $-3714$ $23,653$ $5,261$ $1.6$ 7.1 $6.1$ $5.3$ $17,863$ $-3714$ $23,653$ $5,261$ $1.6$ 3.4 $2.1$ $6.1$ $5.3$ $5,164$ $1.6$ $1.4$ $3.4$ $2.1$ $6.947$ $-2.1483$ $-3714$ $8,853$ $4,869$ $1.7$ $2.0$ $0.5$ $1.612$ $-2.483$ $4.095$ $5,693$ $1.7$ $2.0$ $0.1$ $2.28$ $-3.38$ $616$ $5,335$ $1.7$ $2.0$ $0.1$ $2.28$ $-3.38$ $616$ $5,334$ $1.6$ $2.0$ $0.1$ $2.28$ $-3.38$ $616$ $5,334$ $1.6$ $2.0$ $0.1$ $2.334$ $1.602$					87.01
0.347         9.0 $82$ $27.42$ $3.774$ $23.653$ $5.261$ $16$ $635$ $18190$ $21964$ $2920$ $009$ $10$ 23.833         7.1         6.1 $20.377$ $15141$ $8.833$ $4.860$ $1.4$ $526$ $18190$ $21964$ $3.466$ $109$ $109$ 23.83 $4.6$ $1.2$ $1.8334$ $6.486$ $1.4$ $5020$ $109$ $1.4$ $2.920$ $109$ $1.6$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $109$ $2.920$ $2.911$ $2.920$ $2.911$ $2.920$ <t< td=""><td>0.347 <math>9.0</math> <math>8.2</math> <math>7.427</math> <math>3.742</math> <math>3.761</math> <math>1.6</math> <math>6.5</math> <math>1.8190</math> <math>2.1964</math> <math>2.920</math> <math>0.9</math> <math>1.916</math> <math>2.920</math> <math>0.91</math> <math>2.920</math> <math>0.912</math> <math>2.920</math> <math>0.920</math> <math>2.920</math> <math>0.912</math> <math>0.920</math> <math>0.912</math></td><td>9.0         8.2         <math>27,427</math> <math>3.774</math> <math>23,653</math> <math>5.261</math> <math>1.6</math>           7.1         <math>6.1</math> <math>20.367</math> <math>1.514</math> <math>18,853</math> <math>4.869</math> <math>1.4</math>           6.6         <math>5.3</math> <math>17.863</math> <math>.371</math> <math>18,833</math> <math>4.869</math> <math>1.4</math> <math>3.4</math> <math>2.1</math> <math>6.947</math> <math>-761</math> <math>7.708</math> <math>6.168</math> <math>1.8</math> <math>3.4</math> <math>2.1</math> <math>6.947</math> <math>-761</math> <math>7.708</math> <math>6.168</math> <math>1.8</math> <math>2.0</math> <math>0.5</math> <math>1.612</math> <math>-2.483</math> <math>4.095</math> <math>5.693</math> <math>1.7</math> <math>2.0</math> <math>0.1</math> <math>2.28</math> <math>-3.48</math> <math>6.66</math> <math>5.336</math> <math>1.6</math> <math>2.0</math> <math>0.1</math> <math>2.28</math> <math>-3.38</math> <math>6.66</math> <math>5.336</math> <math>1.6</math> <math>2.0</math> <math>0.1</math> <math>2.28</math> <math>-3.38</math> <math>6.66</math> <math>5.336</math> <math>1.6</math> <math>2.0</math> <math>0.1</math> <math>2.28</math> <math>2.34</math> <math>5.013</math> <math>1.5</math> <math>2.0</math> <math>0.1</math> <math>2.28</math> <math>2.34</math> <math>5.013</math> <math>1.6</math> <math>2.0</math></td><td></td><td></td><td></td><td>2,361</td><td>1,077</td></t<>	0.347 $9.0$ $8.2$ $7.427$ $3.742$ $3.761$ $1.6$ $6.5$ $1.8190$ $2.1964$ $2.920$ $0.9$ $1.916$ $2.920$ $0.9$ $1.916$ $2.920$ $0.9$ $1.916$ $2.920$ $0.9$ $1.916$ $2.920$ $0.9$ $1.916$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.91$ $2.920$ $0.912$ $2.920$ $0.920$ $2.920$ $0.912$ $2.920$ $0.912$ $2.920$ $0.912$ $2.920$ $0.912$ $2.920$ $0.912$ $2.920$ $0.912$ $2.920$ $0.912$ $2.920$ $0.912$ $0.920$ $0.912$	9.0         8.2 $27,427$ $3.774$ $23,653$ $5.261$ $1.6$ 7.1 $6.1$ $20.367$ $1.514$ $18,853$ $4.869$ $1.4$ 6.6 $5.3$ $17.863$ $.371$ $18,833$ $4.869$ $1.4$ $3.4$ $2.1$ $6.947$ $-761$ $7.708$ $6.168$ $1.8$ $3.4$ $2.1$ $6.947$ $-761$ $7.708$ $6.168$ $1.8$ $2.0$ $0.5$ $1.612$ $-2.483$ $4.095$ $5.693$ $1.7$ $2.0$ $0.1$ $2.28$ $-3.48$ $6.66$ $5.336$ $1.6$ $2.0$ $0.1$ $2.28$ $-3.38$ $6.66$ $5.336$ $1.6$ $2.0$ $0.1$ $2.28$ $-3.38$ $6.66$ $5.336$ $1.6$ $2.0$ $0.1$ $2.28$ $2.34$ $5.013$ $1.5$ $2.0$ $0.1$ $2.28$ $2.34$ $5.013$ $1.6$ $2.0$				2,361	1,077
3.8.3         7.1         6.1 $20.367$ 1.514         1.8.351         4.860         1.4         2.0         1.7480         1.894 $3.466$ 1.0         1           11.485         3.3         1.7863         3.3         1.7863         1.8         6.480         1.9         5.70         1.892         8.859         4.393         1.1         2.2           6.05         1.6         2.5         1.6947         7.708         6.168         1.8         4.93         5.93         1.3         2         1.4         2         2         2.2         2.2         2.2         2.3         2.3         2.4         2.6         1.697         4.393         1.1         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9         2.9<	23,833         7.1         6.1 $20,367$ $1.5,14$ $1.8,83$ $4.80$ $1.4$ $2.2$ $1.7460$ $18,944$ $3.466$ $1.0$ $1.3$ $2.3466$ $1.0$ $1.334$ $6.486$ $1.9$ $2.260$ $18,549$ $4.339$ $1.334$ $6.486$ $1.9$ $2.269$ $1.334$ $6.486$ $1.9$ $2.288$ $2.346$ $2.03$ $1.2$ $2.881$ $2.496$ $1.92$ $2.881$ $2.496$ $1.92$ $2.881$ $2.496$ $1.92$ $2.881$ $2.496$ $1.92$ $2.346$ $1.92$ $2.336$ $1.6$ $3.89$ $7.67$ $2.881$ $2.661$ $2.881$ $2.661$ $2.881$ $2.661$ $2.881$ $2.661$ $2.881$ $2.661$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.861$ $2.$	7.1         6.1 $20,367$ $1,514$ $18,853$ $4,869$ $1,4$ 6.6         5.3 $17,863$ $-371$ $18,833$ $6,486$ $1.9$ 3.4 $2.1$ $6,947$ $-761$ $7,708$ $6,168$ $1.8$ $2.0$ $0.5$ $1,612$ $-2,483$ $4,095$ $5,693$ $1.7$ $2.0$ $0.1$ $2.28$ $-3.483$ $4,095$ $5,013$ $1.5$ $2.0$ $0.1$ $2.28$ $-3.483$ $616$ $5,336$ $1.6$ $2.0$ $0.1$ $2.28$ $-3.483$ $616$ $5,336$ $1.6$ $2.0$ $0.1$ $2.28$ $-3.483$ $616$ $5,336$ $1.6$ $2.0$ $0.1$ $2.28$ $-3.283$ $616$ $5,334$ $1.6$ $2.0$ $0.1$ $2.28$ $-3.28$ $616$ $5,334$ $1.6$ $2.0$ $0.1$ $4,722$ $5,334$ $1.6$ $5,334$ $1.6$ <					90.71
2.2.02 $66$ $5.3$ $17,863$ $371$ $6,486$ $10$ $574$ $6,892$ $18,549$ $4,339$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ $11,32$ <	22,002         66         5.3         17,863 $$	6.6 $5.3$ $17.863$ $.371$ $18.234$ $6.486$ $1.9$ $3.4$ $2.1$ $6.947$ $.761$ $7.08$ $6.168$ $1.8$ $2.0$ $0.5$ $1.612$ $-2.483$ $4.095$ $5.693$ $1.7$ $2.0$ $0.2$ $1.612$ $-2.483$ $4.095$ $5.693$ $1.7$ $2.0$ $0.1$ $2.28$ $-3.34$ $6.168$ $1.8$ $2.0$ $0.1$ $2.28$ $-3.483$ $4.095$ $5.033$ $1.7$ $2.0$ $0.1$ $2.28$ $-3.34$ $5.013$ $1.5$ $1.7$ $2.0$ $0.1$ $2.28$ $-3.38$ $616$ $5.336$ $1.6$ $2.3$ $1.4$ $4.868$ $1106$ $4.762$ $5.336$ $1.6$ $2.3$ $0.1$ $2.34$ $2.047$ $1.6$ $1.6$ $2.6$ $0.1$ $0.1$ $2.148$ $1.0835$ $5.047$ $1.5$ $3.5$					83.95
11,445         34         21 $697$ $706$ $6.168$ $1.8$ $4.93$ $5.830$ $5.830$ $5.830$ $5.830$ $5.830$ $5.493$ $1.67$ $4.903$ $1.63$ $2.433$ $1.602$ $2.433$ $1.602$ $5.331$ $1.5$ $2.603$ $1.7$ $4.903$ $1.67$ $4.903$ $1.67$ $4.903$ $1.67$ $2.603$ $1.7$ $4.903$ $1.612$ $2.491$ $1.812$ $2.603$ $1.7$ $4.90$ $6.633$ $2.601$ $1.812$ $2.2612$ $1.60$ $5.3301$ $1.6$ $5.3301$ $1.6$ $5.3301$ $1.6$ $5.3301$ $1.6$ $5.3301$ $1.6$ $2.331$ $2.671$ $2.932$ $2.671$ $2.932$ $2.671$ $2.332$ $2.671$ $2.332$ $2.671$ $2.332$ $2.671$ $2.332$ $2.671$ $2.332$ $2.671$ $2.332$ $2.671$ $2.332$ $2.671$ $2.332$ $2.671$ $2.332$ $2.671$ $2.332$ $2.691$ $2.716$ $2.716$	11,465         3.4         2.1 $6.947$ $7.766$ $6.168$ $1.8$ $4.93$ $8.819$ $4.538$ $1.4$ $2.2$ 6,005 $0.5$ $1.612$ $2.343$ $4.065$ $5.693$ $1.7$ $4.90$ $6.576$ $4.167$ $4.933$ $1.12$ $2.333$ $4.055$ $5.5334$ $1.26$ $3.261$ $1.67$ $2.463$ $1.15$ $2.333$ $2.671$ $2.923$ $2.461$ $1.26$ $2.333$ $4.05$ $5.617$ $2.761$ $2.923$ $2.461$ $2.534$ $1.662$ $5.394$ $1.662$ $5.394$ $1.662$ $5.394$ $1.662$ $5.394$ $1.662$ $5.394$ $1.662$ $5.394$ $1.662$ $5.394$ $1.662$ $5.394$ $1.662$ $5.394$ $1.662$ $5.761$ $2.766$ $5.167$ $2.766$ $5.167$ $2.766$ $1.616$ $1.662$ $5.394$ $1.662$ $5.761$ $2.762$ $2.4906$ $1.56$ $2.766$ $2.167$ $2.762$ $2.496$ $2.762$	3.4 $2.1$ $6,947$ $-761$ $7,08$ $6,168$ $1.8$ $2.0$ $0.5$ $1,612$ $-2.483$ $4,095$ $5,693$ $1.7$ $1.0$ $0.2$ $762$ $5.238$ $2.4483$ $4,095$ $5,693$ $1.7$ $2.0$ $0.1$ $2.28$ $-338$ $616$ $5,336$ $1.6$ $2.3$ $1.4$ $4,868$ $1106$ $4,762$ $5,336$ $1.6$ $2.3$ $1.4$ $4,868$ $1106$ $4,762$ $5,336$ $1.6$ $2.3$ $1.4$ $4,868$ $1106$ $4,762$ $5,336$ $1.6$ $3.5$ $0.14$ $1.263$ $-333$ $1.662$ $4,782$ $5,394$ $1.6$ $3.5$ $0.4$ $1.263$ $-3133$ $1.662$ $4,782$ $5,310$ $1.6$ $3.5$ $0.4$ $1.263$ $1.234$ $1.662$ $5,394$ $1.6$ $3.5$ $0.4$ $1.488$ $1.66$					111.83
6,05 $2,0$ $0.5$ $1,612$ $2.483$ $4,05$ $5,033$ $1,7$ $4,80$ $4,167$ $4,903$ $1,167$ $4,903$ $1,167$ $4,903$ $1,167$ $4,903$ $1,167$ $4,903$ $1,167$ $4,903$ $1,167$ $4,903$ $1,167$ $4,903$ $1,167$ $2,201$ $0,18$ $2,201$ $0,18$ $2,201$ $0,18$ $2,201$ $0,18$ $2,201$ $0,18$ $2,201$ $0,18$ $2,201$ $0,18$ $2,201$ $0,18$ $2,201$ $0,18$ $2,201$ $0,18$ $2,201$ $2,201$ $2,201$ $2,201$ $2,201$ $2,201$ $2,201$ $2,201$ $2,201$ $2,201$ $2,201$ $2,201$ $2,201$ $2,201$ $2,201$ $2,201$ $2,201$ $2,202$ $2,490$ $2,14$ $2 ,202$ $2,490$ $2,14$ $2 ,202$ $2,490$ $2,14$ $2 ,202$ $2,490$ $2,14$ $2 ,202$ $2,490$ $2,14$ $2 ,202$ $2,490$ $2,14$ $2 ,212$	6,665 $2,0$ $0.5$ $1,612$ $-2,483$ $4,095$ $5,033$ $1,7$ $4,80$ $6,650$ $4,167$ $4,993$ $1.5$ $2,03$ $2,691$ $0.15$ $2,03$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $0.8$ $2,691$ $2,191$ $2,192$ $2,191$ $2,192$ $2,191$ $2,192$ $2,191$ $2,192$ $2,1,491$ $2,1,292$ $2,1,491$ $2,1,292$ $2,1,491$ $2,1,292$ $2,1,491$ $2,1,292$ $2,1,491$ $2,1,292$ $2,1,491$ $2,1,292$ $2,1,491$ $2,1,292$ $2,1,492$ $2,1,492$ $2,1,492$ $2,1,492$ $2,1,492$ $2,1,4$	2.0 $0.5$ $1.612$ $-2.483$ $4,095$ $5.693$ $1.7$ 1.0 $0.2$ $762$ $5238$ $2.4$ $5.013$ $1.5$ 2.0 $0.1$ $2.28$ $-338$ $616$ $5.336$ $1.6$ 2.0 $0.1$ $2.28$ $-338$ $616$ $5.336$ $1.6$ 2.3 $1.4$ $4.868$ $1106$ $4.762$ $5.336$ $1.6$ 2.3 $1.4$ $4.868$ $1106$ $4.762$ $5.336$ $1.6$ 3.5 $0.4$ $1.263$ $-339$ $1.662$ $4.782$ $5.394$ $1.6$ 3.5 $0.4$ $1.263$ $-333$ $1.662$ $4.788$ $1.6$ 3.5 $6.6$ $1.2635$ $-413$ $7.768$ $5.110$ $1.5$ 5.0 $1.6$ $1.738$ $1.2448$ $4.986$ $1.5$ 5.0 $1.6$ $21.2448$ $1.9855$ $5.047$ $1.5$ 5.0			<b>538</b> 1.4	221.38	106.35
3,453100.27625282345,0131,53,024,449822,6010.826,7012.090.12.28-3.386165,3361,63897673796,4731997,5832.31.144,8661.004,7625,3361,65332,6712,332,9191996,7331.9-7,665,3361,6024,7625,3941,65332,6712,332,919191,9143.52.641.265-3,391,6024,7625,3471,02,8712,8712,9121,991,9143.52.641.2,632,5041,54,70102832,6712,3324,9961,51,9143.58.061,1,7381,9481,5482,6712,3324,9961,52,6763,791,9141,5385,0471,52,491,52,6764,7621,62,6763,791,9481,9381,9481,9382,6764,9461,52,6764,9461,52,64467563,731,9481,9481,9481,9481,51,41,62,40467563,7451,9481,9481,9481,51,41,62,40467563,7451,9481,9481,61,41,61,604523,71,948 <td>3453       10       0.2       762       528       234       5,013       15       362       454       982       2.091       0.8       2         6,701       2.0       0.1       228      </td> <td>1.0 <math>0.2</math> <math>762</math> <math>528</math> <math>234</math> <math>5.013</math> <math>1.5</math> <math>2.0</math> <math>0.1</math> <math>228</math> <math>-388</math> <math>616</math> <math>5.336</math> <math>1.6</math> <math>2.3</math> <math>1.4</math> <math>4.868</math> <math>106</math> <math>4.762</math> <math>5.394</math> <math>1.6</math> <math>1.9</math> <math>0.4</math> <math>1.263</math> <math>-339</math> <math>1.66</math> <math>4.762</math> <math>5.394</math> <math>1.6</math> <math>3.5</math> <math>2</math> <math>7.355</math> <math>-413</math> <math>7.768</math> <math>5.110</math> <math>1.5</math> <math>3.5</math> <math>6</math> <math>1.263</math> <math>-339</math> <math>1.662</math> <math>4.988</math> <math>1.5</math> <math>3.5</math> <math>6</math> <math>0.4</math> <math>1.263</math> <math>-313</math> <math>1.662</math> <math>4.988</math> <math>1.5</math> <math>5.6</math> <math>4</math> <math>14.186</math> <math>1.738</math> <math>1.2448</math> <math>4.980</math> <math>1.5</math> <math>8.0</math> <math>6</math> <math>21.829</math> <math>1.9855</math> <math>5.047</math> <math>1.5</math> <math>5.047</math> <math>1.9855</math> <math>5.047</math> <math>1.5</math> <math>1.0</math> <math>1.5</math> <math>7.766</math> <math>21.829</math> <math>1.9855</math> <math>5.047</math> <math>1.5</math> <math>1.5</math></td> <td></td> <td></td> <td></td> <td></td> <td>98.15</td>	3453       10       0.2       762       528       234       5,013       15       362       454       982       2.091       0.8       2         6,701       2.0       0.1       228	1.0 $0.2$ $762$ $528$ $234$ $5.013$ $1.5$ $2.0$ $0.1$ $228$ $-388$ $616$ $5.336$ $1.6$ $2.3$ $1.4$ $4.868$ $106$ $4.762$ $5.394$ $1.6$ $1.9$ $0.4$ $1.263$ $-339$ $1.66$ $4.762$ $5.394$ $1.6$ $3.5$ $2$ $7.355$ $-413$ $7.768$ $5.110$ $1.5$ $3.5$ $6$ $1.263$ $-339$ $1.662$ $4.988$ $1.5$ $3.5$ $6$ $0.4$ $1.263$ $-313$ $1.662$ $4.988$ $1.5$ $5.6$ $4$ $14.186$ $1.738$ $1.2448$ $4.980$ $1.5$ $8.0$ $6$ $21.829$ $1.9855$ $5.047$ $1.5$ $5.047$ $1.9855$ $5.047$ $1.5$ $1.0$ $1.5$ $7.766$ $21.829$ $1.9855$ $5.047$ $1.5$ $1.5$					98.15
6,01 $2.0$ $0.1$ $2.8$ $616$ $5,336$ $16$ $339$ $767$ $379$ $6.73$ $10$ 7,583 $2.3$ $1.4$ $4.868$ $106$ $4,702$ $5,344$ $16$ $333$ $267$ $373$ $2.715$ $0.8$ $6,259$ $1.9$ $0.4$ $1.263$ $-3.39$ $1602$ $4,702$ $5,344$ $16$ $373$ $2.715$ $0.8$ $1.5$ $0.8$ $1.5$ $0.8$ $1.5$ $0.8$ $1.5$ $0.8$ $1.5$ $0.8$ $1.5$ $0.8$ $1.5$ $0.8$ $1.5$ $0.8$ $1.5$ $0.8$ $1.5$ $0.8$ $1.5$ $0.8$ $1.5$ $0.8$ $1.5$ $0.8$ $1.5$ $0.8$ $0.511$ $0.8$ $0.511$ $0.8$ $0.511$ $0.8$ $0.511$ $0.8$ $0.511$ $0.8$ $0.512$ $0.512$ $0.512$ $0.6$ $0.512$ $0.512$ $0.512$ $0.512$ $0.512$ $0.51$	(701 $2.0$ $01$ $2.28$ $0.1$ $2.33$ $6.67$ $3.33$ $0.67$ $3.33$ $2.715$ $0.8$ 7.583 $2.3$ $1.4$ $4.868$ $106$ $4.762$ $5.344$ $1.6$ $333$ $2.715$ $0.8$ $0.8$ $0.7$ $373$ $2.715$ $0.8$ $0.8$ $1.5$ $4.988$ $1.5$ $4.98$ $1.5$ $4.98$ $1.5$ $4.98$ $1.5$ $4.98$ $1.5$ $4.98$ $1.5$ $4.98$ $1.5$ $4.98$ $1.5$ $4.98$ $1.5$ $4.76$ $2.332$ $4.996$ $1.5$ $2.332$ $4.996$ $1.5$ $2.332$ $4.996$ $1.5$ $2.47$ $2.332$ $4.996$ $1.5$ $2.47$ $2.332$ $4.996$ $1.5$ $2.47$ $2.332$ $4.996$ $1.5$ $2.47$ $2.332$ $4.966$ $1.5$ $2.47$ $2.332$ $4.946$ $1.5$ $2.44$ $2.364$ $1.676$ $4.946$ $1.5$ $2.44$ <	2.0         0.1         2.28         -388         616         5,336         1.6           2.3         1.4         4,868         106         4,762         5,394         1.6           2.3         1.4         4,868         106         4,762         5,394         1.6           3.5         0.4         1.263         -339         1,602         4,988         1.5           3.5         2         7,355         -413         7,768         5,110         1.5           5.6         4         14,186         1,738         12,448         4,980         1.5           8.0         6         21,829         1,9355         5,047         1.5           5.0         37         10,855         5,047         1.5	454				86.4
7,883         2.3         1.4         4,868         106         4,762         5,394         1.6         533         2.67         373         2.715         0.8           6,259         1.9         0.4         1,263         -339         1,602         4,988         1.5         4,08         2.53         4,996         1.5           11,914         3.5         0.4         1,263         5,110         1.5         4,08         1.5         4,986         1.5         4,986         1.5         4,986         1.5         4,986         1.5         4,986         1.5         4,986         1.5         4,986         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96         1.5         4,96<	7,883         2.3         1.4         4,868         106         4,762         5,394         1.6         533         2.67         373         2.715         0.8           6,259         1.9         0.4         1,263	2.3 $1.4$ $4.868$ $106$ $4.762$ $5.394$ $1.6$ 1.9         0.4 $1.263$ $-339$ $1.602$ $4.988$ $1.5$ 3.5         2 $7.355$ $-339$ $1.602$ $4.988$ $1.5$ 5.6         4 $1.263$ $-313$ $7.768$ $5.110$ $1.5$ 8.0         6 $1.4.186$ $1.738$ $12.448$ $4.980$ $1.5$ 8.0         6 $21.829$ $1.7738$ $12.448$ $4.980$ $1.5$ 8.0 $6$ $21.829$ $1.9855$ $5.047$ $1.5$ 5.0 $3.7$ $1.9855$ $5.047$ $1.5$	767				92
6,259         19         0.4         1,263         -339         1,602         4,988         1.5         4,08         1.5         4,08         1.5         4,906         1.5           11,914         3.5         2         2         7,568         5,110         1.5         4,70         10283         9,870 $4,590$ 1.5           18,888         5.6         4         14,186         1,738         12,448         4,980         1.5         210         2,502         2,602         1,49         1.4           26,713         8.0         6         21,839         1,9,855         5,047         1.5         521         21,028         1,496         1.5           76,041         5.7         12,4,706         4,878         119,855         5,047         1,5         521         21,028         1,5         1,4           76,041         52         37         19         12,4,706         1,9         5,338         1,5,6,791         5,338         1,5         1,1           76,041         52         37         19         12,4,706         19         1,5         1,1         1,1           76,041         52         37         19         1,2	6,259         19         0.4         1,263         -339         1,602         4,988 $I.5$ 408 $I.5$ 408 $I.5$ 4,906 $I.5$ 4,90 $I.5$ 4,906 $I.5$ 4,90 $I.5$ 2,10         2,10	1.9         0.4         1.263         -339         1.602         4.988         1.5           3.5         2         7.355         -413         7.768         5.110         1.5           5.6         4         14.186         1.738         12.448         4.980         1.5           8.0         6         21.829         1.974         19.855         5.047         1.5           5.1         1.4706         1.978         4.983         6.345         1.9         1.5	267				93
11,914         3.5 $2$ 7,355         413         7,768         5,110         1.5         470         10283         9,870         4,550         1.4           18,888         5.6         4         1,186         1,738         12,448         4,980         1.5         494         15,023         16,761         4,702         14           26,775         8.0         6         21,839         1,948         4,980         1.5         23,023         16,761         4,702         14           26,775         8.0         6         21,839         1,9855         5,047         1.5         23,023         16,761         4,702         14           26,791         14         19,855         5,047         1.5         21,023         21,6791         51,338         15           76,044         55         149         19         21         1         21         1         1         1           76,044         52         37         19         12,913         126,791         51,348         15         11           76,044         52         37         19         1         1         1         1         1         1         1 <t< td=""><td>11,914         3.5         <math>2</math>         7,355         413         7,768         5,110         1.5         470         10283         9,870         4,550         1.4           18,888         5.6         4         14,186         1,738         12,448         4,980         1.5         494         15,023         16,761         4,702         14           26,775         8.0         6         21,829         1,9455         5,047         1.5         521         21,028         23,602         1,4         1           26,044         52         3.7         12,4,706         4,878         119,855         6,4,345         19         21,023         23,602         4,946         15         1         4         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1</td><td>3.5         2         7,355         -413         7,768         5,110         1.5           5.6         4         14,186         1,738         12,448         4,980         1.5           8.0         6         21,829         1,974         19,855         5,047         1.5           5.1         3.7         14.166         1,974         19,855         5,047         1.5</td><td></td><td></td><td>996 1.5</td><td>214.5</td><td>86</td></t<>	11,914         3.5 $2$ 7,355         413         7,768         5,110         1.5         470         10283         9,870         4,550         1.4           18,888         5.6         4         14,186         1,738         12,448         4,980         1.5         494         15,023         16,761         4,702         14           26,775         8.0         6         21,829         1,9455         5,047         1.5         521         21,028         23,602         1,4         1           26,044         52         3.7         12,4,706         4,878         119,855         6,4,345         19         21,023         23,602         4,946         15         1         4         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1	3.5         2         7,355         -413         7,768         5,110         1.5           5.6         4         14,186         1,738         12,448         4,980         1.5           8.0         6         21,829         1,974         19,855         5,047         1.5           5.1         3.7         14.166         1,974         19,855         5,047         1.5			996 1.5	214.5	86
I8,888         5.6         4         14,186         1,738         12,448         4,980         1.5         4,910         15,023         16,761         4,702         14,80         15,023         16,761         4,702         16,761         4,702         16,761         4,702         16,761         4,702         16,761         4,702         16,761         21,623         23,602         4,946         15,523         23,602         4,946         15,523         23,602         4,946         15,523         23,602         4,946         15,5         16,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5         15,5	I8,888         5.6         4         14,186         1,738         12,448         4,980 $L_5$ 494 $L_5$ ,023         16,761         4,702 $L_4$ $L_6$ <t< td=""><td>5.6         4         14,186         1,738         12,448         4,980         1.5           8.0         6         21,829         1,974         <b>19,855</b>         5,047         1.5           5.0         37         13,106         4,888         64,345         61,345         1.5</td><td></td><td></td><td>559 1.4</td><td>226</td><td>88</td></t<>	5.6         4         14,186         1,738         12,448         4,980         1.5           8.0         6         21,829         1,974 <b>19,855</b> 5,047         1.5           5.0         37         13,106         4,888         64,345         61,345         1.5			559 1.4	226	88
26,775         8.0         6         21,829         1.9,855         5.047         1.5         521         21,028         23,602         4.946         1.5           76,044         52         37         124,706         4,878         19,858         64,345         19         12,013         13,602         4,946         1.5           76,044         52         124,706         4,878         119,828         64,345         19         121,913         126,791         51,338         15           24,044         52         37         119,828         64,345         19         121,913         126,791         51,338         15         11           76,044         52         37         19         121,913         121,913         126,791         51,338         15         11           76,044         52         37         19         19         121,913         126,791         51,338         15         11           76,044         52         37         19         19         124,916         15         11         15         11         15           76,044         52         37         19         126,916         126,916         15         15         15	26,775 $8.0$ $6$ $21,829$ $1.9,855$ $5.047$ $1.5$ $22,602$ $4.946$ $1.5$ $76,044$ $52$ $37$ $124,706$ $4,878$ $119,828$ $6,3.35$ $19,103$ $126,791$ $51,338$ $15$ $11$ $76,044$ $55$ $124,706$ $19,828$ $6,3.35$ $19$ $121,913$ $126,791$ $51,338$ $15$ $11$ $24,204$ $67$ $56$ $119,828$ $6,3.345$ $19$ $121,913$ $126,791$ $51,338$ $15$ $11$ $24,204$ $67$ $56$ $119,828$ $6,3.345$ $19$ $121,913$ $126,791$ $51,338$ $15$ $24,204$ $55$ $37$ $119,828$ $6,3.345$ $121,913$ $126,791$ $51,338$ $15$ $76,044$ $52$ $37$ $19$ $124,916$ $12,829$ $12,913$ $126,791$ $51,338$ $11$ $76,044$ $52$ $37$ $19$	8.0         6         21.829         1.974         19,855         5.047         1.5           50         37         124.70K         4.878         119,828         64.345         1.5			<b>702</b> 1.4	220.8	86
76,044         52         37         124,706         4,878         119,828         64,345         19         121,913         126,791         51,338           160         149         2         21         1         21         1         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21         21	76,044         52         37         124,706         4,878         119,828         64,345         19         121,913         126,791         51,338           100         149         21         19         21         19         13,6791         51,338         51,338           76,044         52         37         19         19         19         19         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338         51,338 <td< td=""><td>52 32 124 20K 4 828 119 828 64 345</td><td></td><td></td><td></td><td></td><td>87</td></td<>	52 32 124 20K 4 828 119 828 64 345					87
160         149         21           24,204         67         56         19           76,044         52         37         19           76,044         52         37         19           X6,045         52         19         19           X6,044         52         37         19           X6,045         52         19         19           X8,XX         Measured values         XXXX         Calculated values	160         149         21           24,204         67         56         19           76,044         52         37         19           76,044         52         37         19           xxxx         Measured values         19						
67 56 52 37 19 xxxx Mesured values xxx Calculated values	67 56 19 52 37 19 xxx Measured values	160 149			11		
52 37 19 xxxx Measured values xxxx Calculated values	52 37 19 xxx Measured values	67 56			11		
		52 37			15		
	xxxx Waste water heat recovery in operation since 12 february		ruary				

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General Data		Nydalavägen 22, Växjö
	Heat Recovery from wastewater	
New RES	+ Heat pump	
Year installed	2020	
Installation type	EcoClime	
Addr es s	Nydalavägen 22	
Installed capacity [kWp]	15 kW(heatpump)	
Quantity [pieces]	n.a.	
Area [m²]	n.a.	
Slope [°]	n.a.	
Orientation	n.a.	
Est. annual prod. [kWh]	65 MWh	
Annual CO <sub>2</sub> -savings [tons]		
Total Investment cost [€]		

Calculated values Net heat recovery Net heat of what is possible recovery to DHW	% of DHW		54	46	62	80	100	95	12	87	64	44.4	45	
Calculated values Net heat recovery of what is possible	%		06	92	68	88	66	103	08	<i>56</i>	63	87.5	98	
Net heat recovery from waste water	kWh		3085	2803	6419	9769	3745	3764	186	4705	2237	6729	2260	
Inlet average/ Outlet lowest waste water	°C		22,2/7,9	23,1/6,3	24,5/6,2	24,9/6,2	25,0/6,2	24,9/6,1	24,4/9,4	25,4/6,7	25,3/6,2	25,2/6,1	23,9/6,1	
COP, overall calc.			4.5	4.5	4.1	3.7	2.9	3.1	1.9	3.3	4.3	4.7	4.6	
Delivered heat to DHW	kWh		2,700	3,100	4,000	4,300	4,933	4,900	009	4,500	006'£	2,675	2,273	
Measured Delivered heat to heating system	kWh		1,700	3,833	4,400	3,900	500	600	0	2,000	5,033	5,728	4,644	
Electricity to pumps	kWh		69	102	103	101	64	64	22	75	26	105	66	106
Heat produced by heat pump	kWh		788£	7342	2258	8594	5611	5471	341	2099	9888	8435	8869	62669
Electricity to heat pump	kWh		662	1539	1908	2248	1866	1707	155	1900	1849	1706	1423	17100
Monitoring Period		jan-20	feb-20	mar-20	apr-20	maj-20	jun-20	jul-20	2020-08-01**	sep-20	okt-20	nov-20	dec-20	TOTAL

\*=first day of operation was 12th February \*\*=heatpump not in operation 7 Aug-3 Sept

## PVT system - SE1.1 Nydalavägen 22, Växjö

General	Data			-	vägen 22, Växjö
New RES			PVT		
Year insta	lled		2020		7 -7
Installatio	on type		PVT + Heat pump		-
Address	/ [		Nydalavägen 22, Växjö		
	capacity [kWp]		16		
Quantity			10		
Area [m <sup>2</sup> ]	[p.ccco]		96		
Slope [°]					
Orientatio	on			4	
Est. annua	al prod. [kWh]				
	D <sub>2</sub> -savings [tons]				
	stment cost [€]				
	Produced solar electricity	Produced solar heat, via ground heat storage, to heat pump (cold side)	Produced heat by heat pump (warm side) to low district heating	Electricity to heat pump	
jan-20	-	-	-	-	
feb-20		-	-	-	
mar-20		-	-	-	
apr-20		-	-	-	
maj-20		-	-	-	
jun-20		60	4	-	
jul-20		9,229	13,369	-	
aug-20		4,931	4,673	-	
sep-20		3,946	4,478	-	
okt-20		216	6	55	
nov-20 dec-20	-	0	-	54	
TOTAL		-	345	123	
IUIAL	8065	18,382	22,882	232	

xxxx Production of electricity started 1st June 2020, accumulated production June-September=7469 kWh

	Tvin	naren 4, V	/äxjö		(E	BEST-categ	gory SE3
General Data							Arabygata
Refurbished Building			*				
Year built	1945						
Year refurbished	2017-2019		1.4	4			
Address	Arabygatan		11	15			
Building function	Office		11				
Building type	Renting offices			I.SIL		2	
Number of Apartments	-		The case	11 41			
Gross Floor Area (m²) in project	3,340	1	and any ALL	TE!		A COMPANY COMPANY	
Gross Floor Area (m <sup>2</sup> ) in total	9,600	10/10				I CAP Sector	1
Total Investment cost [Euro]	2,620,000	cutery	- television		- TELL		
							Actual
Building Features			Normal pra	ctice/Before	Project target	Design (calc)	("year")
External walls	Parapet insulation	W/m²K	-	35	0.35	0.35	0.35
Roof	Ceiling insulation	W/m <sup>2</sup> K		50	0.25	0.35	0.35
Ground floor	-	W/m <sup>2</sup> K	-	-	-	-	-
Windows (frame & glass)	Triple glazing 2+1	W/m²K		00	1	0.50	0.50
Average U-value of glazings		W/m²K		-	-	-	-
Average g-value of glazings		-			_	-	
Ventilation Flow Rate average	Additional occupants	h	4.	00	5.8	5.80	5.80
Thermal Bridges	-				1		
Air tightness & n50 air change ra	te -						
Ventilation system type	Balance mechanical vent	ilation with he	at recovery (VA	V)			
Energy saving measures	New windows, insulation				ligthing automa	tion DC	
Water saving measures	Taps	,		,,			
Special building materials	-						
Type of Shading	External shading						
Energy Systems		Other infor	mation				
District Heating connection	yes						
Photovoltaic - grid connected	no						
	BEST-Table SE3	Existing building kWh/m <sup>2</sup> yr	Suggested specification	Result Total energy delivered (kWh/m <sup>2</sup> )			
Key Energy figures				2020			
District Heating kWh/m <sup>2</sup> yr		93	52	48	1		
District Cooling, electric, kWh/m	<sup>2</sup> vr	10	21	1	1		
ighting*	,	21	4	4	1		
TOTAL		124	77	53	1		
Decrease			-38%	-57%	1		
*Lightning is a calculated value a lightning from other electricity us			5070	5770	1		

			(B	EST-catego	orv SE3	3)		
Address			Tvinnaren 4, V	0	-, ~	1		
Typology of	f Dwelling		Office	3				
Occupants n	•							
Occupants t								
Ownership	J F -		Private					
Gross floor	area (m <sup>2</sup> )		3340					
	Energy		M easured Val	ues District Heat and	Cooling		Measured Valu	es Electricity
					Ũ			· ·
Monito-								
ring			DH	DH	DC	DC	Electr.	Electr.
Period	kWh	kWh/m <sup>2</sup>	kWh	kWh/m <sup>2</sup>	kWh	kWh/m <sup>2</sup>	kWh	kWh/m <sup>2</sup>
jan-14	151,916	16	125220	13		0	26696	3
feb-14	112,712	12	89460	9		0	23252	2
mar-14	99,389	10	76090	8		0	23299	2
apr-14	74,768	8	50870	5		0	23898	2
maj-14	57,178	6	29750	3		0	27428	3
jun-14	47,660	5	15610	2		0	32050	3
jul-14	49,838	5	8200	1		0	41638	4
aug-14	49,734	5	16780	2		0	32954	3
sep-14	54,957	6	24730	3		0	30227	3
okt-14	74,925	8	44620	5		0	30305	3
nov-14	98,748	10	70590	7		0	28158	3
dec-14	143,598	15	116600	12		0	26998	3
TOTAL	1,015,423	106	668,520	70	0	0	346,903	36
jan-15 feb-15	138,581	14	112380	12		0	26201	3
mar-15	126,101	13	102470	11		0	23631	2
	112,234	12	86430	9		0	25804	3
apr-15	86,986	9	61760	6		0	25226	3
maj-15	70,093	7	45400	5		0	24693 26329	3
jun-15	47,909	5	21580 14750	2		0	26329 34794	3
jul-15	49,544	5	14750	2		0	34794	4
aug-15	50,432	5	30970	1		0	37852	4
sep-15 okt-15	63,419 96,950	7 10	66230	3		0	32449	3
nov-15	96,950 118,535	10	88240	9		0	30720	3
dec-15	118,555	12	103760	9		0	30295	3
TOTAL	1,097,044	14	746,550	78	0	0	350,494	3 37
jan-16		115	141720	15	0	0	28988	37
	170,708	-	107630				20300	3
feb-16	137,429	14	92400	11		0	31028	3
mar-16	123,428	13		10		0		3
apr-16	91,635	10	63290	7		0	28345	3
maj-16	58,410	6	24600	3		0	33810	4
jun-16	48,743	5	12800	1		0	35943	4
jul-16	46,529	5	11890	1		0	34639	4
aug-16	51,619	5	16930	2		0	34689	4
sep-16	55,222	6	20100	2		0	35122	4
okt-16	96,803	10	66780	7		0	30023	3
nov-16	136,286	14	102230	11		0	34056	4
dec-16	143,352	15	106800	11		0	36552	4
TOTAL	1,160,164	121	767,170	80	0	0	392,994	41

1 1 1			120240				25400	
jan-17	164,649	17	129240	13		0	35409	4
feb-17	135,911	14	103940	11		0	31971	3
mar-17	127,284	13	89920	9		0	37364	4
apr-17	107,224	11	74620	8		0	32604	3
maj-17	52,802	6	31490	3		0	21312	2
jun-17	36,469	4	16500	2		0	19969	2
jul-17	32,004	3	13530	1		0	18474	2
aug-17	40,185	4	18590	2		0	21595	2
sep-17	53,200	6	32360	3		0	20840	2
okt-17	85,895	9	65110	7		0	20785	2
nov-17	120,813	13	97430	10		0	23383	2
dec-17	135,774	14	114560	12		0	21214	2
TOTAL	1,092,210	114	787,290	82	0	0	304,920	32
jan-18	155,211	16	132780	14	0	0	22431	2
feb-18	149,740	16	132550	14	0	0	17190	2
mar-18	148,490	16	131750	14	0	0	16740	2
apr-18	87,580	9	70790	7	0	0	16790	2
maj-18	45,841	5	24360	3	2	0	21479	2
jun-18	28,097	3	9360	1	3	0	18734	2
jul-18	25,898	3	4480	0	0	0	21418	2
aug-18	31,423	3	9900	1	0	0	21523	2
sep-18	42,697	4	25080	3	0	0	17617	2
okt-18	81,600	9	62040	6	0	0	19560	2
nov-18	114,912	12	95450	10	0	0	19462	2
dec-18	137,016	14	119640	12	0	0	17376	2
TOTAL	1,048,505	110	818,180	85	5	0	230,320	24
jan-19	163,106	17	143330	15	0	0	19776	2
feb-19	122,674	13	105010	11	0	0	17664	2
mar-19	122,895	13	104090	11	0	0	18805	2
apr-19	84,950	9	65570	7	729	0	18651	2
 maj-19	68,910	7	48590	5	1026	0	19294	2
jun-19	37,385	4	11870	1	5918	1	19597	2
jul-19	35,235	4	14430	2	3282	0	17523	2
aug-19	39,500	4	16200	2	4280	0	19020	2
sep-19	50,363	5	31870	3	569	0	17924	2
okt-19	89,614	9	69970	7	36	0	19608	2
nov-19	107,866	11	90010	9	0	0	17856	2
dec-19	119,263	12	100490	10	0	0	18773	2
TOTAL	1,041,761	109	801,430	84	15,840	2	224,491	23

jan-20	117,324	12	94010	10	0	0	23314	2
feb-20	117,528	12	95240	10	0	0	22288	2
mar-20	116,069	12	92240	10	0	0	23829	2
apr-20	78,977	8	57070	6	232	0	21675	2
maj-20	67,385	7	43700	5	634	0	23051	2
jun-20	47,279	5	13820	1	4534	0	28925	3
jul-20	44,760	5	20940	2	1080	0	22740	2
aug-20	47,717	5	14400	2	4061	0	29256	3
sep-20	55,190	6	28390	3	556	0	26244	3
okt-20	77,640	8	52350	5	119	0	25171	3
nov-20	91,442	10	67810	7	15	0	23617	2
TOTAL	861,311	90	579,970	61	11,231	1	270,110	28

	Energy	r	Measured Val	ues District Heat and	Cooling		Measured Valu	es Electricity
Monito- ring Period	kWh	kWh/m²	DH** kWh	DH** kWh/m²	DC* kWh	DC* kWh/m²	<i>Electr.</i> kWh	<i>Electr</i> . kWh/m²
2014	878,820	92	531,917	56	0	0		36
2015	1,026,927	107	676,433	71	0	0		37
2016	1,123,134	117	730,140	76	0	0		41
2017	1,044,181	109	739,261	77	0	0		32
2018	974,597	102	744,272	78	5	0	230,320	24 *
2019	987,403	103	747,072	78	15,840	2	224,491	23 *
2020***	762,155	80	457,326	48	11,231	1	293,598	31 *
Average 20	14-2016	105		67		0		38
Middle 201	7	109		77		0		32
Average 201	18-2020	95		68		1		26

#### BEFORE MIDDLE AFTER

\* Not adjusted for degree days

\*\* DH adjusted for degree days and hot water use

\*\*\* Not full year, EXTRAPOLATED (DH jan-nov/full year=0,85 in average 2014-2019, DC jan-nov/full year=1 in 2019, EL jan-nov/full year=0,92 in average 2014-2019)

#### xxxx Measured values

xxxx Calculated values

General Data		Nydalavägen, Alabastern
New RES	District Heating	
Year installed	Jan 19	
Installation type		
Address		the bound of the second of the
Installed capacity [kWp]		
Quantity [pieces]		
Area [m <sup>2</sup> ]		
Slope [°]		
Orientation		
Est. annual prod. [kWh]		
Annual CO <sub>2</sub> -savings [tons]		
Total Investment cost [€]		

Demonstration low temperature district heating

105

105

**Delivered Heat to** leat cons med the Alabastern area eat consumed by Electricity COP, COP, Alabastern Area (2 Heat loss COP, heating through the Supply temperature cooling Monitoring Period customers combi. connections) substatio lowering the kWh kWh kWh kWh kWh [-] [-] [-] 421084 421084 #BEZUG! #DIV/0! #BEZUG! Jan 16 Feb 16 364409 364409 0 #BEZUG! #DIV/0! #BEZUG! Mrz 16 356869 356869 #BEZUG! #DIV/0! #BEZUG! 0 Apr 16 282350 282350 0 #BF7UG! #DIV/01 #REZLIG! Mai 16 #BEZUG! #DIV/0! #BEZUG! 169633 169633 0 Jun 16 117315 117315 #BEZUG! #DIV/0! #BEZUG! Jul 16 102552 102552 0 #BFZUG! #DIV/01 #BFZUG! 94211 Aug 16 94211 #BEZUG! #DIV/0! #BEZUG! 0 Sep 16 Okt 16 103527 #RF7UG! #DIV/0! #RF7UG 232085 232085 #BEZUG! #DIV/0! #BEZUG! 0 Nov 16 295139 295139 #BEZUG! #DIV/0! #BEZUG! 0 Dez 16 312915 312915 0 #BEZUG! #DIV/0! #BEZUG! 2852089.003 #DIV/0! TOTAL 2815309 #DIV/0! 0 0 #DIV/0! an 17 #BEZUGI 309810 345574.001 -345574.001 #BEZUG #DIV/0! Feb 17 264713 294748 -294748 #BEZUG! #DIV/0! #BEZUG! Mrz 17 275650 #BEZUG! #DIV/0! #BEZUG! 247793 275650 Apr 17 198914 221816 -221816 #BEZUG! #DIV/0! #BEZUG! Mai 17 -133524.006 #BEZUG! #DIV/0! #BEZUG! 133524.006 #DIV/0! #DIV/0! #BEZUG! #BEZUG! Jun 17 70443 88388 -88388 #BEZUG! #BEZUG! Jul 17 52658 68294 -68294 55350 #BEZUG! #DIV/0! #BEZUG! Aug 17 71832 -71832 Sep 17 Okt 17 80916 103711 -103711 #BEZLIG! #DIV/01 #REZLIG! #BEZUG! #DIV/0! #BEZUG! 133070 168487 -168487 Nov 17 219589.38 #BEZUG! #DIV/0! #BEZUG! 157933 219589.38 Dez 17 176639 264530.615 -264530.615 #BEZUG! #DIV/0! #BEZUG! TOTAL 3721178 2256144.002 -2256144.002 #DIV/0! 0 #DIV/0! #DIV/0 0 an 18 271454 #BFZUG! #DIV/01 #BFZUG! 271454 Feb 18 286548 #BEZUG! #DIV/0! #BEZUG! -286548 Mrz 18 286780 #BEZUG! #DIV/0! #BEZUG! 286780 Apr 18 148899 -148899 #BEZUG! #DIV/0! #BEZUG! Mai 18 65662 -65662 #BEZUG! #DIV/0! #BEZUG! Jun 18 48084 #BFZUG! #DIV/01 #BFZUG! 48084 LT DH in process 40246.997 #DIV/0! #BEZUG! Jul 18 #BEZUG! 40246.997 Aug 18 46958 46958 #BEZUG! #DIV/0! #BEZUG! Sep 18 79042 -79042 #BFZUG! #DIV/01 #BFZUG! . Okt 18 130008.001 #BEZUG! #DIV/0! #BEZUG! -130008.001 Nov 18 149486 14948 #BF7UG! #DIV/0! #REZLIG!

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1740545.998

-178658.001

-184311

-126728.999

-99841

-47804.006

-46666

-47278.001

-74140

-123714

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-90,314

-1414058.004

7625

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2.309

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231015

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102014

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100,550

191730

186430

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54,470

54,380

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107,410

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TOTAL

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LT DH in process

3238343.85 Nov 20 139,560 133794 5.766 4% 0.00 3238343.85 #DIV/0! #DIV/0! #DIV/0! Dez 20 0 TOTAL 1,274,940 1213319.004 61620.997 2009531.56 0.00 2009531.56 0

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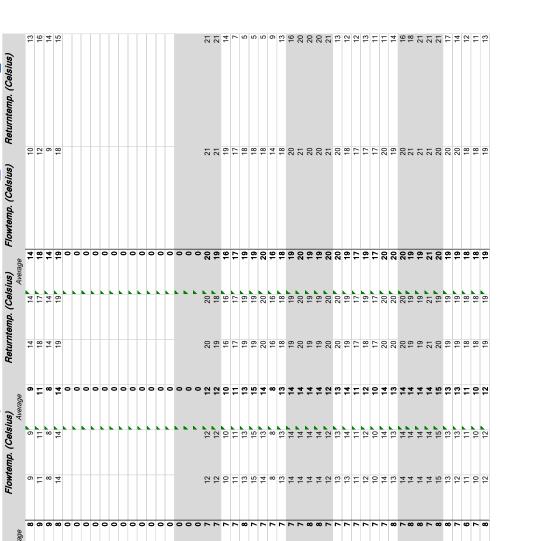
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Statutation with different temperatures in the new         Statuation with different temperatures in the new         Statuation with different temperature in the new         Statuation with different temperature in the new         Supply temperature return temperature from the network in variable in the new         Supply temperature return temperature in the new         Rupply temperature return temperature from the network in variable in the network in th											-90971	vicasuring via substation was started December 16th , 2019	
Statutation with different temperatures in the nework in Vays with normal sturt         Statutation with different temperature in vays with normal sturt         Statutation with different temperature in vays with normal sturt         Statutation with different temperature in vays with normal sturt         Statutation with different temperature in vays with normal sturt         Statutation with supply temperature in vays with normal sturt         Statutation with supply temperature in vays with supply temperature in vays with supply temperature in vays with supply temperature in variance in the variance in variance i											6951		
STANDADD TERRETATURES: as the standard network in Vasio with normal supply temperatures         LUTDH         Number approximation         Supply temperature       Heat loss calculation         84.75       22.78       -3.43       31       -3.43       -3.43       -3.43       -5.60       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00       -6.00	alcul	ation with dif	fferent tempera	tures in t		ystem with th	e new p	ipes and lar	ger dimension and	isolation. (calct	ulation i	s provided	مم
Supply temperature (eturn temperature)         Supply temperature (eturn temperature)         Supply temperature (eturn temperature)         Supply temperature (bys)         Heat loss calculation           73:3         4207         -251         28         -3         314         31         5 MM           73:3         4207         -251         28         -499         314         314         5 MM         6 MM           73:3         35:3         4207         -251         28         304         4 MM         4 MM           75:3         35:6         1134         31         4 MM         4 MM         4 MM           75:3         35:7         8:6         1144         31         4 MM         4 MM           75:3         35:7         8:6         338         30         14 MM         4 MM           75:3         35:7         8:6         314         31         4 MM           75:8         3:6         1442         31         4 MM         4 MM           75:8         3:6         1442         31         4 MM         4 MM           75:8         3:6         1442         314         314         314           77:8         3:8         3:6         <	GH (STA thout LT	NDARD) TEMPERATU	JRES - as the standard ne	twork in Växjö		ply temperatures							
78/7         58/2         314         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         <		Supply temperature Re	sturn temperatur Average	temperature Da	ys		Heat loss	calculation	Comment and conclusio	c			
84.75         42.78		78.87	39.42	3.14		-	Jan	5 MWh	By lowering the temperatu	re the heat losses is minimi	ized by 10 MV	Wh during	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	c .	84.75	42.78	с <u>-</u>	31		Feb	4 MWh	one year.				
73.13         3.2.22         -4.59         31         Anti- May         4 MM           76.14         35.56         10.53         31         100         4 MM           76.17         45.26         15.74         33         100         4 MM           76.18         45.26         15.74         33         100         4 MM           76.18         45.26         15.74         33         4 MM         4 MM           76.18         45.26         14.42         31         4 MM         4 MM           76.18         45.26         14.42         31         4 MM         4 MM           76.19         45.26         34.6         31         4 MM         4 MM           76.19         36.6         31         31.4         31         4 MM           78.17         8.16         31         20         22         12 MM           78.17         0.0         0.0         0.0         0.0         23         11 MM           Immode constant         0.0         0.0         0.0         22         10         10           Immode constant         0.0         0.0         0.0         0.0         23         0.0		83.33	42.07	-2.51	28		March	5 MWh					
76.01         39.06         10.53         37         10.60         4 MMh           75.11         45.26         15.3         31         4 MMh         4 MMh           75.11         45.26         15.4         30         14.42         31         4 MMh           75.11         45.26         15.4         30         349         4 MMh         4 MMh           75.1         45.26         15.4         30         349         37.07         899         3 Mh         4 MMh           75.3         39.42         31.4         31         4 MMh         4 MMh         4 MMh           76.3         39.45         31.4         31         4 MMh         4 MMh         4 MMh           76.5         39.45         31.4         31         4 MMh         4 MMh         4 MMh           76.6         31.4         31         4 MMh         4 MMh         4 MMh         4 MMh           Ilarbelacture (C         8.5         31.4         31         4 MMh         4 MMh           Ilarbelacture (C         8.5         4 MMh         4 MMh         4 MMh         4 MMh           Ilarbelacture (C         8.3         31.4         31.4         31.4         4 MM	- ch	86.86	42.92 38.6	-4.99	31		April	4 MWh	Supprised in how less ener	gy savigings the system ger	nerates with l	MO	
76.07         42.75         13.4         30         0000         0000         4 MMh           75.11         42.68         14.77         31         4 MMh         4 MMh           75.11         42.69         14.77         31         4 MMh         4 MMh           75.11         42.69         14.77         31         4 MMh         4 MMh           75.11         75.9         36.42         314         31         4 MMh           77.6         36.42         314         31         4 MMh         4 MMh           77.6         36.42         314         31         4 MMh         4 MMh           76.8         36.42         314         31         4 MMh         4 MMh           77.6         36.42         314         31         4 MMh         4 MMh           76.8         36.42         314         31         4 MMh         4 MMh           76.8         36.42         314         31         4 MMh         4 MMh           8         36.47         314         31         4 MMh         4 MMh           8         36.47         314         31         4 MMh         4 MMh           8         36.47	- ,	76.84	30.56	10.53	6		lune Lune	4 MM/h	temparature on district he	ating, compared to high ter	mperature DF		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	e	76.07	42.75	13.4	30		July	4 MWh					
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		75.11	45.26	15.77	31		August	4 MWh	Don't feel like it is profitab	le with LI DH systems in Va.	xjo just n	ad the	
	just	76.18	42.69	14.42	31		Sep	3 MWh	task SEK 800,000 in my nec	ad and with the saving SEK	2491 / year it	S	
		75.9	39	9.38	30		Oct	4 MWh	payback time of over 300 y	years			
T7.66         38.6         38.6         38.9         30           Rerage temperature (°C         8.5         3.42         3.14         31           Swerage temperature (°C         8.5         3.42         3.14         31           EMPERATURE - with supply temperature (°C         8.5         3.14         31           Supply temperature (°C         3.3         3.14         31           Su		76.9	37.07	8.16	31		Nov	4 MWh					
T6.87 $39.42$ $3.14$ $31$ average temperature (°C $8.5$ $3.4.4$ $314$ $31$ average temperature (°C $8.5$ $3.4.5$ $3.14$ $31$ Iambda constant $0.03$ $6.5$ $6.5$ $9.5$ Supply temperature (°C $0.03$ $314$ $314$ $314$ $314$ Supply temperature Return temperature Average temperature Days $314$ $314$ $314$ $314$ $314$ Supply temperature Return temperature Average temperature Days $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$ $314$		77.66	38.6	3.89	30		Dec	4 MWh					
average temperature (°C, llambda constant         8.5 (°)         9.3 (°)		78.87	39.42	3.14	31		5						
average temperature (°C         8.5         0.03         8.5         0.03         8.5         0.03         8.5         0.03         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0         9.0<							5.6	12 MWh					
Itambda constant         0.03           EMPERATURE - with supply temperature of 65 degrees yearly         5           Supply temperature Return temperature Days         314           65         31         -2.51           7         10.53         31           65         31         -2.61         30           65         31         -1.61         30           65         31         10.53         31           65         31         115.77         31           65         31         115.77         31           65         31         115.77         31           65         31         314         31           65         31         314         31           65         31         314         31           65         31         314         31           65         31         314         31           65         31         32         <	rlv aver	ade termoerature (°C'	8.5				10	11 MWh					
EINPERATURE - with supply temperatur of 65 degrees yearly           Supply temperature Return temperature degrees yearly           Supply temperature (55         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31	eral lan	bda constant	0.03				4	12 MWh					
EMPERATURE - with supply temperatur of 65 degrees yearly         Supply temperature Return temperature Average temperature Days           Supply temperature Return temperature Average temperature Case         314         31           Supply temperature Return temperature Average temperature Days         -3         -3           Supply temperature Return temperature Average temperature Days         -3         -3           Supply temperature Return temperature Average temperature Days         -3         -3           Supply temperature Return temperature Average temperature Case         31         -3           Supply temperature Return temperature Average temperature Case         31         -251         28           Supply temperature Return temperature Case         31         -251         28         31           Supply temperature ("C         31         -251         28         30         -26           Supply temperature ("C         8.5         31         11.4.4         31         -26         -26           Average temperature ("C         8.5         31         31.4         31         -26         -26           Supply temperature ("C         8.5         31         31.4         31         -26         -26							Yearly	48 MWh					
Supply temperature Return temperature Average temperature Days       314       31         65       31       -3       314         65       31       -3       31         65       31       -251       28         65       31       -251       28         65       31       -251       28         65       31       -261       28         65       31       10.53       31         65       31       11.3.4       30         65       31       15.77       31         65       31       14.4.2       31         65       31       14.4.2       31         65       31       3.14       31         65       31       3.14       31         865       31       3.14       31         90       9.38       30       9.38         91       3.14       31       9.14         11       3.13       3.14       31         91       3.14       31       9.14       31         91       3.14       31       9.14       11         91       3.14       31       9.1 <td>V TEM</td> <td>PERATURE - with sup</td> <td>ply temperatur of 65 degr</td> <td>ees yearly</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	V TEM	PERATURE - with sup	ply temperatur of 65 degr	ees yearly									
65         31         3.14         31         31         Jan           65         31        3         31         1         Jan           65         31        3         31         Antil         Antil           65         31        499         31         Antil         Antil           65         31        499         31         Antil         Antil           65         31         10.53         31         Antil         Antil           65         31         10.53         31         June         June           65         31         15.77         31         Autil         Antil           65         31         15.77         31         Autil         Antil           65         31         14.42         31         Autil         Antil           65         31         31.6         31         Autil         Autil           7         31.8         3.14         31         Autil         Autil           8         31         3.14         31         Autil         Autil           8         65         31         3.14         31         Autil <td></td> <td>Supply temperature Re</td> <td>sturn temperaturi Average</td> <td>temperature Da</td> <td>ys</td> <td></td> <td>Heat loss</td> <td>calculation</td> <td></td> <td></td> <td></td> <td></td> <td></td>		Supply temperature Re	sturn temperaturi Average	temperature Da	ys		Heat loss	calculation					
66         31         -3         31         Feb           65         31         -2.51         28         March           65         31         -2.61         28         April           65         31         -2.61         30         March           65         31         -2.61         30         March           65         31         10.53         31         April           65         31         11.43         30         June           114         31         11.43         30         June           65         31         11.42         31         August           65         31         11.42         31         Nov           65         31         31.6         31         Nov           65         31         31.8         30         Dec           1         56         31         31.4         30         Dec           1         56         31         31.4         30         Dec           1         56         31         31.4         31         Dec           1         56         31         31.4         31         Dec		65	31	3.14			Jan	4 MWh					
65         31         -2.51         28         March           65         31         -2.51         28         March           65         31         -2.51         28         March           65         31         2.61         30         March           65         31         10.53         31         June           65         31         13.4         30         June           65         31         14.42         31         June           65         31         14.42         31         Nov           65         31         14.42         31         Nov           65         31         3.38         30         Oct           8.16         31         3.14         31         Nov           8.5         31         3.14         31         Oct           9.65         31         3.14         31         Oct           9.65         31         3.14         31         Oct           9.66         0.03         0.03         Oct         Oct           9.66         0.03         0.03         Oct         Oct           11mbdda constant         0.		65	31	ę	31	-	Feb	3 MWh					
65         31         -4.99         31         -4.99         31         April           65         31         2.61         30         May         May           65         31         10.53         30         May         June           65         31         10.57         31         June         June           65         31         14.42         30         May         June           65         31         14.42         31         Sep         Oct           65         31         14.42         31         Sep         Oct           65         31         14.42         31         Sep         Oct           65         31         3.14         31         Sep         Oct           865         31         3.14         31         Oct         Oct           average temperature (°C         8.5         Oct         Oct         Oct         Oct           1         314         31         314         31         Oct         Oct         Oct           average temperature (°C         8.5         0.03         Oct         Oct         Oct         Oct           1         0.0		65	31	-2.51	28		March	4 MWh					+
Merical Section         31         1.5.01         30         Merical Section         31         Marcal Section         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         31         <	- cu	65 65	31	-4.99	51		April	4 MWN AMMb					
No         No<		00 92	3	10.53	6		line	3 MWh					
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	е	65	31	13.4	30		July	3 MWh					
65         31         14.42         31         Sep         3           65         31         9.38         30         Oct         3         3           65         31         8.38         30         Nov         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3 </td <td></td> <td>65</td> <td>31</td> <td>15.77</td> <td>31</td> <td>_</td> <td>August</td> <td>3 MWh</td> <td></td> <td></td> <td></td> <td></td> <td></td>		65	31	15.77	31	_	August	3 MWh					
65         31         9.38         30         Oct         3           65         31         8.16         31         Nov         3           65         31         3.18         30         Dec         3           65         31         3.14         31         Nov         3           19         930         Dec         3         14         3           10         8.5         31         3.14         3         11         11           11         31         8.15         0.03         Dec         3         3         3         3         3         14         3         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14         14	ust	65	31	14.42	31		Sep	3 MWh					
Nov         31         0.10         31         0.10         31         0.00         3           65         31         3.89         30         0         0ec         3         3           65         31         3.14         31         314         3         11         11           10         11         3.14         31         3.14         3         14         11         11           11         13         14         31         3.14         31         14         11         11           11         13         14         31         3.14         31         14         11         11           11         11         11         3.14         31         14         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11         11		65	31	9.38	30		Oct	3 MWh					
65         31         314         31         314         31           65         31         3.14         31         3.14         31         0.1           1/y average temperature (°C, astronomic constant         8.5         0.03         0.03         0.03         0.03		00 6F	3	3.80	0			3 MMVh					
Ire (C, 8.5 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.		65	31	3.14	3.15		222						
Tite (°C, 8.5 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.							g	11 MWh					
0.03	arly aver	age temperature (°C)	8.5			-	62	9 MWh					
	neral lan	lbda constant	0.03				82	8 MWh dww					
							5						-

Mathematical control of the second	Non-control         Control and contro and control and control and contro and control and cont			SPORT CENTRE			DATA CENTRE			
	$ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$	Football st	adium -delivered heat		Delivered heat to SPORT CENTRE	Si C	cooling wexnet GD	° CNV	Wexnet - total demand DC return	eturn
	1000 $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $10000$ $10000$ $100$	8			N3C N0	26.42	(194139) Value (MWh) MISSING DATA	(231458) Value (MWh)	13 07	20000
	0.0         0.00         0.00         0.00         0.00           0.1         0.00         0.00         0.00         0.00           0.1         0.00         0.00         0.00         0.00           0.1         0.00         0.00         0.00         0.00           0.1         0.00         0.00         0.00         0.00           0.1         0.00         0.00         0.00         0.00           0.1         0.00         0.00         0.00         0.00           0.1         0.00         0.00         0.00         0.00           0.1         0.00         0.00         0.00         0.00           0.1         0.00         0.00         0.00         0.00           0.1         0.00         0.00         0.00         0.00           0.1         0.00         0.00         0.00         0.00           0.1         0.00         0.00         0.00         0.00           0.1         0.00         0.00         0.00         0.00           0.1         0.00         0.00         0.00         0.00           0.1         0.00         0.00         0.00         0.00     <	Jan 10	000.0	107.15			-00.04 25.00		13.07	%00°0
	(1, 1) $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$ $(1, 1)$	Mrz 16	0.000	A VEV ES		00.00	38.05		92.11	0.00%
	(1)         (2)         (2)         (2)         (2)         (2)           (2)         (2)         (2)         (2)         (2)         (2)           (2)         (2)         (2)         (2)         (2)         (2)           (2)         (2)         (2)         (2)         (2)         (2)           (2)         (2)         (2)         (2)         (2)         (2)           (2)         (2)         (2)         (2)         (2)         (2)           (2)         (2)         (2)         (2)         (2)         (2)           (2)         (2)         (2)         (2)         (2)         (2)           (2)         (2)         (2)         (2)         (2)         (2)           (2)         (2)         (2)         (2)         (2)         (2)           (2)         (2)         (2)         (2)         (2)         (2)           (2)         (2)         (2)         (2)         (2)         (2)           (2)         (2)         (2)         (2)         (2)         (2)           (2)         (2)         (2)         (2)         (2)         (2)	Apr 16	58.520	10.984		39.32	39.45		78.77	74.29%
	100 $100$ $00$ $00$ $00$ $00$ $100$ $100$ $100$ $000$ $000$ $000$ $100$ $100$ $100$ $000$ $000$ $000$ $100$ $100$ $100$ $100$ $000$ $000$ $100$ $100$ $100$ $100$ $000$ $000$ $100$ $100$ $100$ $100$ $000$ $000$ $100$ $1000$ $1000$ $1000$ $000$ $000$ $1000$ $1000$ $1000$ $1000$ $000$ $000$ $1000$ $1000$ $1000$ $1000$ $000$ $000$ $1000$ $1000$ $1000$ $1000$ $000$ $000$ $1000$ $1000$ $1000$ $1000$ $000$ $000$ $1000$ $1000$ $1000$ $1000$ $000$ $000$ $1000$ $1000$ $1000$ $1000$ $000$	Mai 16	12.240	0.274			41.19		82.33	14.87%
	100 $000$ $000$ $000$ $000$ $000$ $000$ $000$ $000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $0000$ $00$	Jun 16	0.040	0			40.24		80.55	0.05%
	Add         Condition         Condition <thcondition< th=""> <thcondit< td=""><td>Jul 16</td><td>0.010</td><td>0</td><td></td><td></td><td>41.38</td><td></td><td>83.08</td><td>0.01%</td></thcondit<></thcondition<>	Jul 16	0.010	0			41.38		83.08	0.01%
	0.00         0.00         0.00         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01         0.01 <t< td=""><td>Aug 16</td><td>0.110</td><td>0</td><td></td><td></td><td>42.04</td><td></td><td>84.2</td><td>0.13%</td></t<>	Aug 16	0.110	0			42.04		84.2	0.13%
	0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000         0.000 <t< td=""><td>Sep 16</td><td>0.490</td><td>0</td><td></td><td></td><td>41.09</td><td></td><td>82.19</td><td>0.60%</td></t<>	Sep 16	0.490	0			41.09		82.19	0.60%
	0.00 $0.00$ $0.00$ $0.00$ $0.00$ $0.00$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$ $0.01$	Okt 16	3.060	60.543			42.07		83.67	3.66%
	All         All         All         All         All         All         All           (11)         (11)         (11)         (11)         (11)         (11)         (11)           (11)         (11)         (11)         (11)         (11)         (11)         (11)           (11)         (11)         (11)         (11)         (11)         (11)         (11)           (11)         (11)         (11)         (11)         (11)         (11)         (11)           (11)         (11)         (11)         (11)         (11)         (11)         (11)           (11)         (11)         (11)         (11)         (11)         (11)         (11)           (11)         (11)         (11)         (11)         (11)         (11)         (11)           (11)         (11)         (11)         (11)         (11)         (11)         (11)           (11)         (11)         (11)         (11)         (11)         (11)         (11)           (11)         (11)         (11)         (11)         (11)         (11)         (11)           (11)         (11)         (11)         (11)         (11)         (11) <td>Nov 16</td> <td>4.130</td> <td>38.162</td> <td></td> <td></td> <td>39.62</td> <td></td> <td>79.14</td> <td>5.22%</td>	Nov 16	4.130	38.162			39.62		79.14	5.22%
	(a)           (a)         (a)         (a)         (a)         (a)         (a)         (a)         (a)         (a)         (a)         (a)         (a)         (a)         (a)         (a)         (a)         (a)         (a)         (a)         (a)         (a)         (a)         (a)	01 787	0000	P		20.24	46.02		60.40	
	(a)         (a)         (a)         (a)         (a)           (b)         (b)         (b)         (b)         (b)           (b)         (b)         <	Total 2016	105.120	249.147	354.267				r 960.11	10.95%
	(1) $(1)$ $(1)$ $(1)$ $(1)$ $(1)$ $(1)$ $(1)$ $(1)$ $(1)$ $(1)$ $(1)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(1)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(1)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(1)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(1)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(1)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(1)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(1)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$ $(2)$									
	(1, 1) $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$ $(1, 2)$	Jan 17 Eath 17	0 00	0 26 25			42.55		85.02	0000
	(0,0) $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,0)$ <	Mrz 17	79.12	33.629			45.61		91.12	40.42%
	(0,1) $(2,2)$ $(0,0)$ $(2,2)$ $(0,0)$ $(2,0)$ $(0,1)$ $(0,1)$ $(0,1)$ $(0,0)$ $(0,0)$ $(0,0)$ $(0,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(0,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(0,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(0,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(0,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(0,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(0,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(0,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(0,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(0,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$	Apr 17	80.61	0.918			46.42		92.69	86.97%
	(10) $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$ $(10)$	Mai 17	26.27	•0			49.95		99.8	26.32%
	u(1) $0.01$ $0.01$ $0.01$ $0.02$ $0.02$ $0.02$ $0.02$ $0.01$ $0.01$ $0.02$ $0.00$ $0.02$ $0.02$ $0.01$ $0.02$ $0.02$ $0.02$ $0.02$ $0.02$ $0.01$ $0.02$ $0.02$ $0.02$ $0.02$ $0.02$ $0.01$ $0.02$ $0.02$ $0.02$ $0.02$ $0.02$ $0.01$ $0.02$ $0.02$ $0.02$ $0.02$ $0.02$ $0.01$ $0.02$ $0.02$ $0.02$ $0.02$ $0.02$ $0.01$ $0.02$ $0.02$ $0.02$ $0.02$ $0.02$ $0.01$ $0.02$ $0.02$ $0.02$ $0.02$ $0.02$ $0.01$ $0.02$ $0.02$ $0.02$ $0.02$ $0.02$ $0.01$ $0.02$ $0.02$ $0.02$ $0.02$ $0.02$ $0.01$ $0.02$ $0.02$ $0.02$ $0.02$ $0.02$ $0.01$	Jun 17	0.12	•0			47.3		94.72	0.13%
No.         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00	Mail $Mail         Mail           $	Jul 17	0.07	0			48.83		97.85	0.07%
	$m_1$ $m_2$ <t< td=""><td>Aug 17</td><td>0.1</td><td>0</td><td></td><td></td><td>48.87</td><td></td><td>98.2</td><td>0.10%</td></t<>	Aug 17	0.1	0			48.87		98.2	0.10%
	(0,1) $(1,2)$ $(1,2)$ $(1,2)$ $(1,2)$ $(1,2)$ $(1,2)$ $(0,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(1,2)$ $(1,2)$ $(1,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(1,2)$ $(1,2)$ $(1,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(1,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(1,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(1,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(1,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(1,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(1,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(1,1,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(1,1,1)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ $(2,3)$ </td <td>Okt 17</td> <td>3.88</td> <td></td> <td></td> <td></td> <td>40.04</td> <td></td> <td>C0.06</td> <td>2014 10 20</td>	Okt 17	3.88				40.04		C0.06	2014 10 20
0.01         1.03         0.041         0.042         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0.043         0	Date         Table         Based         Based         Calify	Nov 17	7.18	8.179			46.22		93.22	7.70%
No.         Math	017         345.4         945.7         345.1         945.7         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         345.1         3	Dez 17	7.59	18.868		47.57	47.78		95.35	7.96%
1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1	not $not         not         not< not         not< not< not< not< not< not< not< not not< not         <$			1 Chill CO	010 010				50 57	1
	1000 $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $1000$ $10000$ $10000$ $100$	ai 2017	245.34	7/0.86	343.912				90'0111	K96'17
(a)         (a) <td>Fe         <math>113</math> <math>1133</math> <math>11333</math> <math>11333</math> <math>1133</math><td>Jan 18</td><td>7.09</td><td>43.485</td><td></td><td></td><td>49.29</td><td></td><td>98.37</td><td>7219</td></td>	Fe $113$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $1133$ $11333$ $11333$ $1133$ <td>Jan 18</td> <td>7.09</td> <td>43.485</td> <td></td> <td></td> <td>49.29</td> <td></td> <td>98.37</td> <td>7219</td>	Jan 18	7.09	43.485			49.29		98.37	7219
WU         SID         UN	$M_{12}$ $63.234$ $61.834$ $61.834$ $64.65$ $M_{12}$ $92.2$ $0.00$ $0.80$ $64.65$ $M_{11}$ $0.00$ $0.000$ $64.65$ $64.65$ $M_{11}$ $0.000$ $0.000$ $51.65$ $64.65$ $M_{12}$ $0.000$ $0.000$ $0.000$ $51.65$ $M_{12}$ $330.01$ $330.02$ $23.63.5$ $64.61$ $M_{12}$ $330.01$ $330.02$ $23.63.5$ $64.61$ $M_{12}$ $300.01$ $330.02$ $23.63.5$ $64.61$ $M_{12}$ $300.01$ $330.02$ $23.63.5$ $64.51$ $M_{12}$ $300.01$ $23.65.5$ $13.65.5$ $64.51$ $M_{12}$ $30.01$ $33.65.5$ $13.65.5$ <	Feb 18	41.16	51.833			43.99		87.93	46.819
0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0	Matrix $Bard$ $A11$ $Bard$	Mrz 18	90.78	63.094			47.62		95.25	95.31%
000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000         000 <td>Mail         Other         Other</td> <td>Apr 18 Mai 18</td> <td>58.72 9.22</td> <td>3.11</td> <td></td> <td></td> <td>48.09</td> <td></td> <td>103.12</td> <td>%90.10 %0.08</td>	Mail         Other	Apr 18 Mai 18	58.72 9.22	3.11			48.09		103.12	%90.10 %0.08
10         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0	Math         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0 <td>Jun 18</td> <td>0.05</td> <td>0</td> <td></td> <td></td> <td>48.69</td> <td></td> <td>97.6</td> <td>0.05%</td>	Jun 18	0.05	0			48.69		97.6	0.05%
400         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00         0.00	Mail         0.000         0.241         0.000         0.241           Mail         319         36.147         0.000         96.31           Mail         733         36.147         23.823         96.36           Mail         733         35.017         23.823         96.36           Mail         91.01         53.41         23.833         46.41           Mail         91.01         53.21         23.833         46.41           Mail         91.01         53.21         23.833         46.41           Mail         91.01         53.21         23.833         46.43           Mail         91.01         53.25         113.853         45.36           Mail         23.83         75.64         06.46         45.46           Mail         23.83         75.64         06.46         55.2           Mail         23.83         75.64         06.46         55.2           Mail         23.83         75.64         06.46         55.2           Mail         23.83         75.9         55.8         55.4           Mail         23.83         14.30         55.2         55.4           Mail         23.33 <td>Jul 18</td> <td>0</td> <td>•0</td> <td></td> <td></td> <td>51.47</td> <td></td> <td>103.32</td> <td>\$00.0</td>	Jul 18	0	•0			51.47		103.32	\$00.0
0.8         0.8         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0.02         0	69:16         0.02         0.02         0.061         0.061           00:18         7.3.3         56.1.2         2.3.3.2         66.5           10:18         7.3.3         56.1.2         3.3.3.67         2.3.3.2         66.5           10:18         36.1.2         3.3.3.67         2.3.3.2         66.53         44.1           10:18         36.0.1         26.1.2         3.3.3.67         17.5.65         44.1           10:19         30.0         7.3.65         0.4.1.2         69.2.2         44.1           10:19         30.0         7.5.65         0.4.1.2         69.2.2         44.1           10:19         31.65         11.7.55         0.4.1         51.2         51.3           10:19         30.1         37.65         0.4.1         50.2         51.3           10:19         31.3         11.55         11.55         14.3         51.3           10:19         30.3         11.35         0.46         51.3         51.3           10:19         31.3         11.35         14.30         55.2         51.3           10:19         31.3         11.35         14.30         55.2         51.3           10:19         3	Aug 18	0.02	0			51.86		104.27	0.02%
0011         3.3         5.0.4         9.33         5.0.4         9.33         5.0.4         9.33         5.0.4         9.33         5.0.4         9.33         5.0.4         9.33         5.0.4         9.33         5.0.4         9.33         5.0.4         9.33         5.0.4         9.33         5.0.4         9.33         5.0.4         9.33         5.0.4         9.33         5.0.4         9.33         5.0.4         9.33         5.0.4         9.33         5.0.4         9.33         5.0.4         9.33         7.345         7.345         7.346         7.345         7.346         7.345         7.346         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.346         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         7.345         <	0.01(8) $3.19$ $2.6.147$ $9.2.32$ $9.6.16$ $0.01(8)$ $3.30$ $2.6.137$ $9.2.32$ $9.6.16$ $0.01(8)$ $3.6.07$ $3.6.037$ $3.6.037$ $9.6.162$ $4.6.14$ $0.01(8)$ $9.6.12$ $3.6.037$ $9.6.162$ $4.6.14$ $4.6.14$ $0.01(8)$ $9.6.16$ $5.6.167$ $9.6.162$ $4.6.14$ $4.6.14$ $0.01(9)$ $9.6.10$ $5.6.167$ $1.12.862$ $4.6.14$ $4.6.14$ $0.102$ $9.6.10$ $5.6.167$ $1.12.862$ $4.6.17$ $5.1.24$ $0.1102$ $9.327$ $1.12.862$ $9.6.16$ $5.1.24$ $0.1102$ $9.327$ $1.14.50$ $5.5.2$ $5.1.24$ $0.1102$ $0.282$ $0.060$ $5.5.2$ $5.1.24$ $0.1102$ $0.282$ $0.060$ $5.5.2$ $5.1.24$ $0.1102$ $0.126$ $0.060$ $5.5.2$ $5.1.24$ $0.1102$ $0.126$ $0.160$ $5.5.2$	Sep 18	0.92	0			50.25		100.88	0.91%
0.0         6.13         3.301         5.303         5.301         5.303         5.301         5.303         5.301         5.303         5.301         5.303         5.301         5.303         5.301         5.303         5.301         5.303         5.301         5.303         5.301         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.303         5.	Note         Sector         Sector <td>Okt 18</td> <td>3.19</td> <td>26.142</td> <td></td> <td></td> <td>50.24</td> <td></td> <td>100.77</td> <td>3.17%</td>	Okt 18	3.19	26.142			50.24		100.77	3.17%
0.000         3000         3000         3000         3000         3000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000         4000 <t< td=""><td>100 <math>300</math> <math>450</math> <t< td=""><td>Nov 18</td><td>73.8 05.12</td><td>25.013</td><td></td><td></td><td>48.4</td><td></td><td>97.04</td><td>/6.05%</td></t<></td></t<>	100 $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $300$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ $450$ <t< td=""><td>Nov 18</td><td>73.8 05.12</td><td>25.013</td><td></td><td></td><td>48.4</td><td></td><td>97.04</td><td>/6.05%</td></t<>	Nov 18	73.8 05.12	25.013			48.4		97.04	/6.05%
10.10         56.21         10.26         46.45         10.35         46.45         10.35         46.45         10.35         46.45         10.35         46.45         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35         10.35 <th< td=""><td>Min         Min         Min</td></th<> <td></td> <td>380.07</td> <td>200.00 248 182</td> <td>-</td> <td></td> <td>40.00</td> <td></td> <td>1181 68</td> <td>20.10%</td>	Min		380.07	200.00 248 182	-		40.00		1181 68	20.10%
Image         940         951 <sup>1</sup> 1930         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         443         4	Intell         9404         952.1         150.200         46.4 $1001$ 239.6         756.467         105.405         64.51 $1011$ 239.6         756.467         105.416         51.86 $1011$ 239.8         0.05.407         64.51         51.86 $1011$ 0.72         0.07.80         51.86         51.86 $1011$ 0.72         0.72         0.730         51.86 $1010$ 0.72         0.72         0.700         51.86 $1010$ 0.72         0.72         0.700         51.86 $1010$ 0.72         0.72         0.700         51.86 $1010$ 0.73         0.73         0.700         55.26 $1010$ 0.73         0.730         145.60         55.27 $1010$ 0.73         113.600         145.60         55.56 $1010$ 0.73         113.600         145.60         57.66 $1010$ 0.73         113.600         145.60         57.66 $1010$ 0.73         113.600         55.65         57.66	2	10-000	701-044	440-FA				5	
Feb (b) $303$ $7063^{\circ}$ $7132$ $4.3$ $4.3$ $4.3$ $4.3$ $6.3$ $7.363$ $7.363$ $7.363$ $7.363$ $7.363$ $7.363$ $7.363$ $7.363$ $7.363$ $7.363$ $7.364$ $7.364$ $7.364$ $7.364$ $7.373$ $7.373$ $7.364$ $7.374$ $7.364$ $7.374$ $7.364$ $7.374$ $7.364$ $7.374$ $7.364$ $7.374$ $7.364$ $7.374$ $7.364$ $7.374$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$ $7.364$	(b)         (b)         (b)         (b)         (b)         (c)         (c) <td>Jan 19</td> <td>94.04</td> <td>56.21</td> <td></td> <td></td> <td>48.45</td> <td></td> <td>96.93</td> <td>97.02%</td>	Jan 19	94.04	56.21			48.45		96.93	97.02%
Mr 29         3.5.66 $1.5.46^{\circ}$ $1.6.46^{\circ}$ 1.6.46^{\circ}         1.6.46^{\circ}	$M_{2}$ $32.36$ $7.54.6^{10}$ $0.61.6$ $51.81$ $M_{10}$ $33.82$ $7.54.6^{10}$ $0.61.6$ $51.81$ $M_{10}$ $33.82$ $1.317^{10}$ $33.82$ $51.24$ $51.34$ $M_{10}$ $0.72$ $0.72$ $0.72$ $0.72$ $51.24$ $51.34$ $M_{10}$ $1.47$ $0.82$ $0.72$ $0.72$ $0.72$ $51.25$ $M_{10}$ $0.82$ $0.72$ $0.72$ $0.72$ $0.72$ $55.22$ $M_{10}$ $0.147$ $0.72$ $0.72$ $0.880$ $55.22$ $M_{10}$ $0.133$ $1.336^{10}$ $1.450$ $55.22$ $M_{11}$ $2.13.72^{10}$ $1.43.6^{10}$ $51.31$ $M_{10}$ $0.133$ $21.34.7^{10}$ $11.332^{10}$ $55.51$ $M_{11}$ $0.133$ $0.13.66^{10}$ $51.37^{10}$ $55.51$ $M_{11}$ $0.133$ $0.13.67^{10}$ $11.332^{10}$ $55.51$ $M_{11}$ $0.13.67^{10}$	Feb 19	80.19	37.663			43.75		87.65	91.49%
Mail         Mail <t< td=""><td>Martine         39.800         0.01         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         &lt;</td><td>Mrz 19 Arv 10</td><td>29.96</td><td>75,456</td><td></td><td></td><td>49.98 51 16</td><td></td><td>101.84</td><td>29.42%</td></t<>	Martine         39.800         0.01         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         0.020         <	Mrz 19 Arv 10	29.96	75,456			49.98 51 16		101.84	29.42%
$u_0(3)$ $0.22$ $0.436$ $0.466$ $0.466$ $0.466$ $0.466$ $0.646$ $0.646$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ $0.064$ <	Juni 3         0.72         0.72         51.36           Juli 3         1.47         0.7         1.40         56.32           Aug 13         1.47         0.7         1.40         56.32           Aug 13         1.43         0.7         1.40         56.32           Sup 13         1.43         0.7         0.406         55.17           Sup 13         1.430         0.406         55.17         115.40         55.32           Sup 13         113.47         115.40         55.31         115.40         55.31           Dat 19         112.11         22.755         115.356         115.356         57.65           Dat 19         112.11         22.755         115.356         51.66         57.65           Dat 19         112.11         22.755         115.356         51.66         57.65           Dat 19         111.335         115.336         115.336         57.65         57.65           Dat 19         111.335         115.336         115.336         57.65         57.65           Dat 19         111.322         58.97         115.332         57.65         57.65           Dat 19         1117.322         58.37         115.332	Mai 19	39.88	0			54.42		108.17	36.879
$Mail         1.47 0^{0} 1.40 562 574 1.46 1.446 1.446 1.446 1.446 1.446 1.446 1.446 1.446 1.446 1.1246 0.682 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 552 $	Jul 19     1,47     0     1,470     56.2       Jul 19     1,470     56.2     56.2       Sty 19     0,53     1,454     56.2       Ox119     53.33     1,387     1,450     56.25       Ox19     53.33     1,387     1,6608     55.17       Ox19     0,73     2,3275     1,6608     57.17       Dar 19     112.11     2.2775     166.08     57.16       Dar 19     112.11     2.2775     166.08     57.66       Jun 20     114.05     113.435     57.66     57.66       Jun 20     114.42     114.435     116.539     56.97       Jun 20     114.62     114.62     117.322     56.97       Jun 20     111.06     6.327     117.322     56.97       Fea 20     111.10     2.33.704     117.322     56.97	Jun 19	0.72	•0			54.98		109.34	0.66%
Add         Dolation         0.08         0.08         0.86.2         0.66.9         0.17.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40         117.40	And         0         0.86         0.86         852           And         1450         0.86         552           Anticle         0         0         1450         552           Anticle         0.1         1.16         552         517           Anticle         0.1         1.266         553         517           Darie         13.35         13.35         513         553           Darie         107         2233         13.35         553           Darie         111         2233         13.35         553           Anticle         11.3.66         13.35         553           Anticle         11.3.66         553         553           Anticle         11.3.66         553         553           Anticle         11.3.66         11.3.35         553           Anticle         5.37         11.3.35         563           Anticle         5.37         11.3.35         563           Anticle         5.37         11.3.35         563           Anticle         5.37         11.3.22         563           Anticle         5.37         11.3.22         563           Anticle	Jul 19	1.47	•0			57.54		114.46	1289
60019     1454     0     1450     558     1137     1137       04119     633     533     553     566     1137     1137       0412     1337     1338     6668     517     593     11507     7       0413     133     3337     11387     5607     11507     7     11507       0414     11111     2.2376     116337     5607     567     11507     7       0416     11111     2.2376     116337     5607     567     11507     7       0416     5033     21366     567     567     567     11507     7       0416     1131     2.2376     116337     5607     567     11507     7       0416     5033     21366     567     567     567     11507     7       0418     5034     116339     567     567     116339     7       0418     11108     6227     11732     569     5947     1       1440     11108     6227     11732     569     5947     1       1440     11108     6227     11732     569     5947     1       1440     11108     6227     11732     569	Sep 1         11.54         0         11.540         55.22           OM 19         0.13         13.86         57.17         57.17           Nav 19         1.13         3.3.7         11.867         55.11           Nav 19         1.12         3.3.7         11.837         55.31           Nav 19         1.12         2.2.755         11.8.37         55.31           Nav 19         1.12         2.2.755         11.8.48         55.66           Dita         987.33         2.1.0.66         91.0.86         57.65           Pin 20         11.132         21.3.026         91.0.86         57.65           Pin 20         11.132         2.1.3.026         11.7.322         56.97           Pin 20         11.132         6.327         11.7.322         56.97           Pin 20         11.1.322         5.32.76         11.7.322         56.97	Aug 19	0.89	0			58.97		117.49	0.76%
Out19         0.333         11.36%         0.6313         5.71         5.33         11.30%         0         11.30%         0         0           bbv 19         10         0         3.37         116.30%         55.71         55.31         56.07         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30%         11.30% <t< td=""><td>Out19         0.3.33         1.3.86         0.468         5.3.1           Dar 19         10.7         9.3.37         16.408         5.3.1           Dar 19         10.7         9.3.37         16.408         5.3.1           Dar 19         10.7         2.3.36         16.408         5.3.1           Dar 19         11.2.1         2.2.755         19.4.365         5.3.6           Jun 20         11.2.1         2.2.756         19.0.666         5.3.6           Jun 20         11.4.92         1.4.60         116.339         56.9           Fea 20         11.1.06         6.3.42         117.322         56.97           Fea 20         111.06         6.3.42         117.322         56.97           Fea 20         111.06         6.3.42         117.322         56.97</td><td>Sep 19</td><td>14.54</td><td>0</td><td></td><td></td><td>55.85</td><td></td><td>111.37</td><td>13.06%</td></t<>	Out19         0.3.33         1.3.86         0.468         5.3.1           Dar 19         10.7         9.3.37         16.408         5.3.1           Dar 19         10.7         9.3.37         16.408         5.3.1           Dar 19         10.7         2.3.36         16.408         5.3.1           Dar 19         11.2.1         2.2.755         19.4.365         5.3.6           Jun 20         11.2.1         2.2.756         19.0.666         5.3.6           Jun 20         11.4.92         1.4.60         116.339         56.9           Fea 20         11.1.06         6.3.42         117.322         56.97           Fea 20         111.06         6.3.42         117.322         56.97           Fea 20         111.06         6.3.42         117.322         56.97	Sep 19	14.54	0			55.85		111.37	13.06%
Novula     111.11     223.24     113.64     36.01     113.14     113.64       Novula     111.11     223.25     133.36     59.65     58.56     58.56     113.36     113.36       Novula     111.11     223.26     133.36     59.65     58.56     59.47     113.36     113.37       Min 2010     114.69     111.08     59.47     113.32     59.47     114.49     114.49       Min 2010     111.08     6.427     111.322     56.97     57.22     59.47     114.49     7       Min 2010     111.08     6.427     117.322     56.97     57.22     59.47     114.49     7	Nov         11/1         2.3.3/         11.6.4/         56.3           Dor 19         11.11         2.2.75         13.436         57.65           Dor 19         697.33         21.3.66         13.436         57.65           One 10         11.11         2.2.75         13.436         57.65           One 20         11.12         2.3.3.66         113.436         57.65           Jam 20         11.482         1.13.32         56.97           Fea 20         111.06         6.3.27         117.322         56.97           Fea 20         11.1         353.74         117.322         56.97	Okt 19	63.33	1.368			57.9		115.07	55.04%
Old Total         S97.37         213.423         10.060         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0 <td>2010         997.33         213.626         907.34         213.626         907.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66</td> <td>Nov 19</td> <td>101</td> <td>9.35/</td> <td></td> <td></td> <td>50.07</td> <td></td> <td>111.38</td> <td>20.0.89 20.73ec</td>	2010         997.33         213.626         907.34         213.626         907.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66         90.66	Nov 19	101	9.35/			50.07		111.38	20.0.89 20.73ec
Jun 20     114.32     1.469     10.589     59.47     10.589     59.47       Jun 20     111.08     6.2.27     117.322     56.97     57.22     114.49       Fea 20     111.08     6.2.27     117.322     56.97     57.22     114.49	Jan 20 111.02 1.469 1.1630 55.9 55.9 113.339 55.9 55.9 111.02 1.469 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.11.03 1.	tal 2019	597.33	213.626		5	0.64		1292	46.23%
11422     10.60 <sup>6</sup> 116.330     59.47     59.47     118.37       11108     6.342 <sup>7</sup> 117.322     56.97     57.82     114.97       11108     6.342 <sup>7</sup> 117.322     56.97     57.82	114.22 1.465 1.639 55.9 111.08 6.242* 117.22 56.97 111.08 1.712* 56.97									
	111.08 6.34.2 117.322 56.97 383.704 383.704	Jan 20	114.92	1.469			59.47		118.37	\$2.09%
	383.704	Feb 20	111.08	6.242			57.52		114.49	97.02%
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Building	Energy Spec	cificatio	n Table (BEST)	Community / site	Aarhus	Ringgärden afd 21	BEST no.
1,1	Building Categor	rv	residential retrofited	total area / catego	ory / BEST sheet [2]	23960 m <sup>2</sup>	
		-	1 Social multiappartment housing				
1.2	Local Climate			January average	outside temperature	°c	0
1,2	Local Glimate				utside temperature	°C	16
	Climatic Zone		Temperate	Average global h		kWh/m <sup>2</sup> yr	1000
	(national definition		Denmark DK	Annual heating de		°Cd/yr	2700
	(national centrico		Deminer on	Room temperatur		°C	20
			1		1 1	1 1	
1,3	Maximum requir	ements of	building fabric	Existing building [5]	National regulation for new built [6]	suggested specification [7] *)	Energy savings [%] [8]
	Façade/wall	U	W / m2K	0,7	0,3	0,15	78,6
	Roof	U	W / m2K	0,5	0,2	0,1	80,0
	Ground floor	U	W / m2K	0,75	0,2	0,3	60,0
	Glazing	Ug	W / m2K	2,9	1,4	0,8	72,4
	Average U-value	Uav	W / m2K	n.a.	0,22	0,21	n.a.
	Glazing	g `	total solar energy transmittance of glazing		none	0,5	n.a.
	Shading	Fs	Shading correction factor	n.a.	none 126 m2/dual	external	n.a.
	Ventilation rate [4]		air changes/hr *) will depend on optimisation analysis	0,7	126 m3/dwel	0,3-0,6	n.a.
		<u> </u>	) whill depend on optimisation analysis				
2	Building Energy	Performan	ce l				
2,1	Encourse down and		atel used are different flows area (bible / sec	Aug in all suretains in			
41	Energy demand	per m <sub>2</sub> or t	otal used conditioned floor area (kWh / m	zyr) inci. system i	National		
energy carrier existing building	suggested energy carrier		specify energy efficiency measures [13]	Existing building [5]	regulation / normal practice for new built (2006) [6]*	suggested specification [7]	% Energy savings [8]
leating + ven	tilation						
istrict Heating	Low temp water	kWh/m <sup>4</sup> yr	Insulation, windows, tightness, accummulation	121	66	36	70,2
coling + ven	tilation						
ompressor	Water & air	kWh/m <sup>2</sup> yr	Sunshading	0	0	0	#DIV/01
entilation (if	separate from heatin	(a/cooing)		_			
lectricity	Air	kWh/m <sup>2</sup> yr	Intelligent demand controlled, energy eff fans	14	7	7	50,0
ighting							
	Electricity PV	k/Wh/m <sup>2</sup> yr	Daylight access + LED + controls	12	6	4	66,7
			*) Figure includes common lighting only			- "	
omestic Hot	Water (DHW)						
istrict Heating	Waste water HP	kWh/m <sup>2</sup> yr	Taps, Heat recovery, Smart grid control, reduced circ, loss	34	28	19	44,1
ther energy	demand		Teduced Circ. Kiss				
lectricity	PV & Thermal solar	kWh/m <sup>2</sup> vr	Freq. contrl, red. idle load, a++ lenergy labels	13	9	8	38,5
			meters				
		kWh/m <sup>2</sup> yr	Subtotal sum of energy demand	194	116	74	61,9
	Appliances (plea	se indicate,	but costs are not eligible)				
	Electricity	kWh/m²yr	a++apliances, user campaign, PV etc	50	45	30	40,0
2.2	RES contribution	per m2 of	total used conditioned area (KWh / m2 vr				
total					National	Suggested	RES
production		kW		Existing	regulation /	specification	contribution
kWh/yr	m <sup>2</sup> installed	installed	specify RES measures	building [5]	normal practice	[7]	[%][8]
150000	1000	135	PV partly building integrated	0	0	6	8,5
070000	900	360	Solar thermal integrated with DH	0	0	11	15,2
270000			05% DEC is wants heat from Dil	0	0	34	46,4
822913		n.a.	85% RES in waste heat from DH				
822913 23963		n.a.	Waste water heat pump on selected blocks	0	0	3	4,5
822913							

# Appendix B – BEST

	Energy Spec						
1,1	Building Catego	y	tertiary retrofited	total area / categ	ory / BEST sheet [2]	2.068	m <sup>2</sup>
			1 Administration				
				-			
1,2	Local Climate				outside temperature	°C	0
					outside temperature	°C	16
	Climatic Zone		Temperate	Average global h	orizontal radiation	kWh/m <sup>2</sup> yr	1000
	(national definition	)	Denmark DK	Annual heating d	egree days [3]	°Cd/yr	2700
				Room temperatur	e	°C	20
					N - 1/ 1		-
				Existing	National regulation for new	suggested specification	Energy savings [%]
1.3	Maximum requir	ements of t	ouilding fabric	building [5]	built [6]	[7] *)	[8]
.,=							
	Façade/wall	U	W/m2K	0,7	0,3	0,15	78,6
	Roof	U	W / m2K	0,5	0,2	0,1	80,0
	Ground floor	U	W / m2K	0,75	0,2	0,3	60,0
	Glazing	U,	W / m2K	2,9	1,4	0,8	72,4
	Average U-value	Uav	W / m2K	n.a.	0,22	0,22	n.a.
	Glazing	g	total solar energy transmittance of glazing [	5 n.a.	none	0,5	n.a.
	Shading	F8	Shading correction factor	n.a.	none	external	n.a.
	Ventilation rate [4]		air changes/hr	0,7	126 m3/dwel	0,3-0,6	n.a.
	└─── <u>┤</u>	<u>├───</u> ├	*) will depend on optimisation analysis	+ +			
2	Building Energy	Performan	0				
-							
2,1	Energy demand	per m2 of t	otal used conditioned floor area (kWh / m2	2yr) incl. system I			
					National		
energy					regulation /		
carrier	suggested			Existing	for new built	suggested	W. Engen
existing building	energy carrier		specify energy efficiency measures [13]	building [5]	(2006) [6]*	specification [7]	% Energy savings [8]
a dan dan ng	Garrier		spearly energy enderroy measures [10]	building [0]	(2000)[0]	11	dennigo [o]
leating + vent	lation						
District Heating	Low temp water	kWh/m <sup>2</sup> yr	Insulation,windows,tightness, accummulation	81	66	36	55,6
Cooling + vent	lation						
Compressor	Water & air	kWh/m <sup>2</sup> yr	Sunshading	5	5	0	100,0
							1001-
/entilation (if s	eparate from heating	q/cooling)					
lectricity	Air	kWh/m <sup>2</sup> yr	Intelligent demand controlled, energy eff fans	14	10	7	50.0
aberreity	~		meingen, demand conscient, einergy ein faha		10	<u> </u>	50,0
ighting							
	Electricity PV	kWh/m²yr	Daylight access + LED + controls	16	11	8	50,0
omestic Hot V	Nater (DHW)						
Joineauc Hot 4	valuer (Drive)				_		
listrict Heating	Waste water HP	kWh/m²yr	Taps, Heat recovery, Smart grid control,	15	13	10	33,3
			reduced circ. loss				
Other energy d	emand						
lectricity	PV & Thermal solar	kWh/m <sup>2</sup> yr	Freq. contrl, red. idle load, a++ lenergy labels	13	15	9	30,8
			meters				
		kWh/m <sup>2</sup> yr	Subtotal sum of energy demand	144	120	70	51,4
							_
	Appliances (plaz	so indicate 1	sut costs are not eligible)				
	-spinances (ploa		san saana are rish engewer	-	_		
	Electricity	kWh/m <sup>2</sup> yr	a++apliances, user campaign, PV etc	50	45	30	40,0
2,2	RES contribution	per m2 of	total used conditioned area (kWh / m2 yr)			-	
total					National	Suggested	RES
production	2	kW	1. 0.50	Existing	regulation /	specification	contribution
kWh/yr	m <sup>2</sup> installed	installed	specify RES measures	building [5]	normal practice	[7]	[%][8]
36000	240	32	PV partly building integrated	0	0	17	24,8
0 90372	0	0	Solar thermal 95% RES in District Heating	0	0	0 44	0,0 62,3
		n.a.	95% RES in District Heating	0	0	44	62,3
00012		1.8.	1949	0			
0		15	Possible share in common wind turbine	0	0	9	12.9
0		15	Possible share in common wind turbine	0	0	9	12,9

Building	Energy Spec	cincatio	on Table (BEST)	+	Community / site	Aarhus	houses		BEST no.	D
1,1	Building Categor		1 houses	•	total area / categ	ory / BEST sheet [2]	10.000	m²		
1,2	Local Climate				January average	outside temperature	°C	-	D	Ť
.,	Loon chinate			+		outside temperature	°C	-	16	1
	Climatic Zone		Temperate	٦.		orizontal radiation	kWh/m <sup>2</sup> yr		1000	1
	(national definition	1	Denmark DK	+	Annual heating d		°Cd/yr	-	2700	t
	(national determinor	Ϋ́ –	Derman Die	-	Room temperatu		°C	-	20	1
				-	Room temperate			-	20	t
1,3	Maximum requir	ements of	building fabric		Existing building [5]	National regulation for new built [6]	suggested specification [7] *)		Energy savings [%] [8]	
	Facade/wall	U	W / m2K	+	0.7	0.3	0.3	<u>n</u>	57.1	÷
	Roof	Ŭ	W / m2K	-	0,4	0,3	0.12	Ľ	70.0	÷.
	Ground floor	U	W / m2K	-	0,75	0.2	0,12	t	n.a.	Ť.
	Glazing	U,	W / m2K	-	2,9	1,4	0,8		72,4	t
	Average U-value	Uw	W / m2K excl windows & doors	-	n.a.	0.22	0.22	1	n.a.	÷
			total solar energy transmittance of glaz	ing It		0,22	0.5	⊢	n.a.	ł
	Glazing Shading	g Fs	Shading correction factor	ng [:	n.a.	none	external	1	n.a. n.a.	÷
	Ventilation rate [4]		air changes/hr	-	0.7	126 m3/dwel	0.3-0.6	-	n.a.	÷
	vermanon rate (4)		*) will depend on optimisation analysis		0,2	120 Moldwor	0,0-0,0		11.64.	Ť.
2	Building Energy	Performar	100							
										Ŧ
2,1	RES contribution	1 per m2 o	f total used conditioned area (kWh / m)	z yr)	- on top of scale	National		-		+
energy carrier existing building	suggested energy carrier		specify energy efficiency measures [13	1	Existing building [5]	regulation / normal practice for new built (2006) [6]*	suggested specification [7]		% Energy savings [8]	
leating + vent	tilation									t
istrict Heating	Low temp water	kWh/m <sup>2</sup> yr	Insulation, windows, tightness, accummulation	on -	121	66	60		50.4	Ť.
				_						1
Cooling + ven	tilation						-			÷
Compressor	Water & air	kWh/m <sup>2</sup> yr	Sunshading		0	0	0		#DIV/0!	ł
entilation (if a	separate from heatin	ng/cooling)								t
lectricity	Air	kWh/m²yr	Intelligent demand controlled, energy eff fa	ns	10	7	7	É	30,0	Ť
				_						1
ighting							_			
	Electricity PV	kWh/m <sup>2</sup> yr	Daylight access + LED + controls	_	12	6	3		75,0	1
and a star black	Martin - (Philippi)		*) Figure includes common lighting only	4			•)	-		+
Domestic Hot	Water (DHW)			-						+
istrict Heating	Waste water HP	kWh/m <sup>2</sup> yr	Taps, Heat recovery, Smart grid control,		34	28	19		44,1	Т
			reduced circ. loss							T
ther energy	demand									T
Jectricity	PV & Thermal solar	Millham <sup>2</sup> ar	Freq. contrl, red. idle load, a++ lenergy lab	- de	17	9	5	t –	70.6	Ť.
sectricity	PV & Thermal solar	Kvynim yr	meters	2015		9			10,8	1
		kWh/m <sup>2</sup> yr	Subtotal sum of energy demand		194	116	94		51,5	j.
										t
	Appliances (plea	se indicate,	but costs are not eligible)							Ŧ
	Electricity	kWh/m <sup>2</sup> yr	a++apliances, user campaign, PV etc		50	45	30		40,0	]
2,2	RES contribution	per m2 of	f total used conditioned area (kWh / m2	2 yr)						t
total				F		National	Suggested	-	RES	Ŧ
production	and bastellard	kW			Existing	regulation /	specification		contribution	
kWh/yr 75000	m <sup>2</sup> installed	installed	specify RES measures	+	building [5]	normal practice	[7]	1	[%][8]	÷
75000	500	68	PV partly building integrated Solar thermal integrated with DH	+	0	0	8	-	10,0	ł
18000 639200	60	30	Solar thermal integrated with DH 85% RES in waste heat from DH	-	0	0	2 64	1	2,4 85,0	ł
20000		n.a.	Supplementary heat pumps	+	0	0	2	1	2,7	ł
20000	<u> </u>	$\vdash$	Completence and y needs pumps	+	0	0	4	t	0.0	t
				_	<u> </u>	· · · · ·		1		Ť
				_				_		- 1-

building E	nergy speci	ncation	Table (BEST)	Community / site	Växjö	Sweden	BEST no.
1,1	Building Catego		•	total area / cate	ory / BEST sheet [2]	17494 m	1
			1 Kv. Alabastern-Växjö				
1,2	Local Climate				e outside temperature	°C	-0,9
					outside temperature	°c	17,3
	Climatic Zone				norizontal radiation	kWh/m² yr	942
	(national definition	n)	zone 3 - southern Sweden	Annual heating	degree days [3]	°Cd/yr	3715
				Room temperate	ire	°C	20
1,3	Maximum requir	rements of b	uilding fabric	Existing building [5]	National regulation- BBR19 (2012)* [6]	suggested specification [7]	Energy savings [%] [8]
	Façade/wall	U	W / m2K	0,36		0,36	
	Roof	U	W / m2K	0,236		0,073	69
	Ground floor	U	W / m2K	0,413		0,413	
	Glazing	Ua	W / m2K	2,50		0,90	64
	Average U-value	Um	W / m2K	0,710	0,500	0,475	33
	Glazing			76	0,000	46	33
		R Fs	total solar energy transmittance of glazing [%] Shading correction factor	61		36	<u> </u>
	Shading Ventilation rate 1/		air changes/hr	0,609		0,609	<b>⊢</b> →
	Ventilation rate [4	9	air changesmr	0,009	· · · · · ·	0,609	
2	Building Energy	Performanc	e				
2,1			tal used conditioned floor area (kWh / m2yr) i	ncl. system losse	5		
energy carrier				Existing		suggested	% Energy
existing building	suggested energy carrier		specify energy efficiency measures [13]	building [5]	National regulation- BBR:19 (2012)* [6]	specification [7]	savings [8]
eating				1-1			1-1
i	<u> </u>		Additional insulation of attic joists,	149		25	
district heating	district heating	kWh/m <sup>2</sup> yr	Replacement of windows			- 23	
entilation				total distr.heating			
district heating	district heating	kWh/m <sup>2</sup> yr	Air handling units with supply and exhaust air, and energy recovery			21	
omestic Hot W	ater (DHW)						
district heating	district heating	kWh/m²yr	Individual measurement of cold and hot water,			21	55
ther energy de	mand						otal distr heating
<u> </u>	<u> </u>		Electricity to the building, (fans, pumps,				
electricity	electricity	kWh/m <sup>2</sup> yr	etc.)	11		8	27
		kWh/m <sup>2</sup> yr		160	90	75	53
	Appliances (plea	se indicate, b	ut costs are not eligible)				
			Class A++ or A+ Appliances, LED ligth,				
	I I		Meaqsuring and Behaviour changing			1 1	I I
	electricity	kWh/m <sup>2</sup> yr	solutions	46		33	28
	Food						
			Solutions for lowering food waste and			_	
		Co2/m <sup>2</sup> yr	promoting change of diet.	67		57	15
	Avoided emission	ons in societ	v				
		-				-	<u> </u>
		Co2/m <sup>2</sup> yr	Decreased emisions from waste and water treatment				0
		kWh/m <sup>2</sup> yr		46	0	33	28
		CO2/m <sup>2</sup> yr		67	0	57	15
					0	or	15
2,2			ntribution per m2 of total used conditioned an biomass (=RES) and 5% fossil fuel	sa (kWh / m2 yr)			
	second reading in	101010-001				suggested	RES
otal production		kW		Existing	National regulation	specification	contribution
kWh/yr	m <sup>2</sup> installed	installed	specify RES measures	building [5]	BBR19 (2012)* [6]	. [7]	[%][8]
	<b>⊢</b> ]	$\vdash$					
		kWh/m <sup>2</sup> yr	Subtotal sum of RES contribution	0	0	0	0

			n Table (BEST)				_
1,1	Building Catego	ry	•	total area / catego	ary / BEST sheet [2]	4133	m²
		[1	Kv.Alabastern-Växjö, plus prototypes		[]		
1.2	Local Climate		i i i i i i i i i i i i i i i i i i i	January average	outside temperature	°C	-0.9
					utside temperature	°C	17.3
	Climatic Zone			Average global ho		kWh/m <sup>2</sup> yr	942
	(national definitio	n)	zone 3 - southern Sweden	Annual heating de		°Cd/yr	3715
				Room temperatur		°C	20
		· · ·		Existing	National	suggested	Energy
				building	regulation-BBR19	specification	savings
1,3	Maximum requi	rements of	building fabric	[5]	(2012)* [6]	171	[%] [8]
	Facade/wall	U	W / m2K	0,36	<u> </u>	0,36	
	Roof	U	W / m2K	0,236		0.073	76
	Ground floor	U	W / m2K	0,413		0,413	
	Glazing	U <sub>0</sub>	W / m2K	2,50		0,90	64
	Average U-value	U <sub>zy</sub>	W / m2K	0,710	0,500	0,475	33
	Glazing	g	total solar energy transmittance of glazing [%]	76		46	
	Shading	Fs	Shading correction factor	61		36	
	Ventilation rate [4	la l	air changes/hr	0,609		0,609	
2	Building Energy	Performen	ce.				
2,1				eventeur leaner			
energy	suggested	per inz of t	otal used conditioned floor area (kWh / m2yr) incl.	Existing	National	suggested	56
carrier	energy			building	regulation-BBR19	specification	Energy
existing	carrier		specify energy efficiency measures [13]	[5]	(2012)* [6]	[7]	savings
feating							
			Additional insulation of attic joists, Replacement		<u> </u>		
distaint bounding	district heating	kWh/m <sup>2</sup> yr	of windows	149		24	
district heating	district heating	Kontom yr		total dista banting			
/entilation				total distr.heating			
entracion							
			Air handling units with supply and exhaust air, and	1		21	
district heating	district heating	kWh/m <sup>2</sup> yr	energy recovery	· · · · ·	<u> </u>		
Domestic Hot W	ater (DHW)						
						21	
district heating	district heating	kWh/m <sup>2</sup> yr	Individual measurement of cold and hot water,				55
						b	otal distr.hea
Other energy de	mand					_	_
electricity	electricity	kWh/m <sup>2</sup> yr	Electricity to the building, (fans, pumps, etc.)	11		8	27
				160	90	75	53
		kWh/m <sup>2</sup> yr		160	30	/ə	33
	Appliances (ple	ase indicate,	but costs are not eligible)				
			Class A++ or A+ Appliances, LED ligth, Meagsuring				
	I I	kWh/m <sup>2</sup> yr	and Behaviour changing solutions	46		33	29
	Food						
	1000		And the second				
	I I	Co2/m <sup>2</sup> yr	Solutions for lowering food waste and promoting chances of dist	67		57	15
			change of diet		<u> </u>		10
	Avoided emissi	ons in socie	ty				
		Co2/m <sup>2</sup> yr	treatment				0
		kWh/m <sup>2</sup> yr		46	0	11	~
					0	33	29
		CO2/m <sup>2</sup> yr		67	0	57	15
2,2			ontribution per m2 of total used conditioned area (i	(Wh / m2 yr) - on to	p of scale-of-unit o	osts	
	district heating in	Vāxjō is 95%	biomass (=RES) and 5% fossil fuel				
total				Existing	National	suggested	RES
production kWh/yr	m <sup>2</sup> installed	kW installed	specify RES measures	building [5]	regulation-BBR19 (2012)* [6]	specification [7]	contribu- tion
50000	m installed 300	207	Solar collectors to make hot water -PVT	0	120127 [0]	22	aon
39000		257	Solar collectors to make electricity - PVT	0	<b>├───</b> ┤	9	
31028	n.a.	n.a.	Waste water heat pump	0		8	
0.0000	11. ØL	1.0.	riverse water meat pump	*			

	1	-	n Table (BEST)	Community / site	Växjö	Sweden	BEST no.
1,1	Building Catego		•	total area / categ	ory / BEST sheet [2]	13567 n	n <sup>2</sup>
			Kv.Bärnstenen-Växjö				
1,2	Local Climate			January average	outside temperature	°C	-0,9
				August average of	utside temperature	°C	17,3
	Climatic Zone			Average global h	orizontal radiation	kWh/m <sup>2</sup> yr	942
	(national definition	1)	zone 3 - southern Sweden	Annual heating d	egree days [3]	°Cd/yr	3715
				Room temperatur	e	°C	20
		· · · ·		Existing	National	suggested	Energy
				building	regulation-BBR19	specification	savings [%]
1,3	Maximum requir	ements of	building fabric	[5]	(2012)* [6]	[7]	[8]
	Facade/wall	U	W / m2K	0.36		0,36	
	Roof	U	W / m2K	0,236		0,073	69
	Ground floor	U	W / m2K	0,413		0,413	
	Glazing	Ua	W / m2K	2,50		2,50	
	Average U-value	U <sub>av</sub>	W / m2K	0,710	0,500		
	Glazing	g	total solar energy transmittance of glazing [%]	76			
	Shading	Fs	Shading correction factor	61			
	Ventilation rate [4		air changes/hr	0,609		0,609	
		<u> </u>					
2	Building Energy					_	
2,1		per m2 of 1	total used conditioned floor area (kWh / m2yr) inc				
energy	suggested			Existing	National	suggested	% Energy
carrier	energy carrier		manife anorre officiancy manufact (12)	building [5]	regulation-BBR19	specification	savings (8)
existing	carrier		specify energy efficiency measures [13]	0	(2012)* [6]	171	181
eating				_		_	
I	1 1		Thermal photography, air tightness test and	157	I I	33	
strict heating	district heating	kWh/m <sup>2</sup> yr	tightning measures , additional insulation of				
			attic joists etc. optimization of heating	total distr.heating			
entilation			system, ref. temp in each apartment				
			Air handling units with supply and exhaust air, and			21	
strict heating	district heating	kWh/m <sup>2</sup> yr	energy recovery			21	
omestic Hot V	Vater (DHW)						
					_		-
strict heating	district heating	kWh/m <sup>2</sup> yr	Water and energy saving taps and showers			21	75
ther energy d	omand						total distr.heatir
					_		
electricity	electricity	kWh/m <sup>2</sup> yr	Electricity to the building, (fans, pumps, etc.)	16		11	
		LIAD. 1. 2.		173	90	86	
		kWh/m <sup>2</sup> yr		173	30	00	
	Appliances (plea	se indicate.	but costs are not eligible)				
	<u> </u>		Class A++ or A+ Appliances, LED ligth,	<u> </u>	<u> </u>		
	electricity	kWh/m <sup>2</sup> yr	Meagsuring and Behaviour changing solutions	46	I I	33	28
	Food	· · · · /					
	Food		Solutions for lowering food waste and promoting		-		_
	1 1	Co2/m <sup>2</sup> yr	change of diet	67	I I	57	15
		-				wr	13
	Avoided emission	ons in socie	ity				
			Decreased emisions from waste and water				
		Co2/m <sup>2</sup> yr	treatment				0
		kWh/m <sup>2</sup> yr		46	0	33	28
		CO2/m <sup>2</sup> yr		67	0	57	15
	<b>RES</b> (building in	tegrated) o	ontribution per m2 of total used conditioned area	(kWh / m2 yr)			
2.2			biomass (=RES) and 5% fossil fuel				
2,2	district heating in		eren eren 1	Existing	National	suggested	RES
2,2 total	district heating in			Evidentia			
		kW		building	regulation-BBR19	specification	contribution
total	district heating in m <sup>2</sup> installed	kW installed	specify RES measures		regulation-BBR19 (2012)* [6]		contribution [%][8]
total production			specify RES measures	building		specification	
total production			specify RES measures	building		specification	
total production			specify RES measures	building		specification	

1,1	Building Catego		•	total area / categ	ory / BEST sheet [2]	2045 m <sup>2</sup>	1
1,2	Local Climate	[]	Kv.Bärnstenen-Växjö, plus prototypes		autolata tanan anati ma	°c	-0,9
1,2	Local Climate				outside temperature		
					utside temperature	°C	17,3
	Climatic Zone				orizontal radiation	kWh/m <sup>2</sup> yr	942
	(national definitio	n)	zone 3 - southern Sweden	Annual heating d	egree days [3]	°Cd/yr	3715
		<u> </u>		Room temperatur	9	°C	20
				Existing	National	suggested	Energy
1.3	Maximum regui	rements of	building fabric	building [5]	regulation-BBR19 (2012)* [6]	specification [7]	savings [%] [8]
	Façade/wall	U	W / m2K	0,36		0,36	<u> </u>
	Roof	ŭ	W/m2K	0,236		0,073	69
	Ground floor	Ŭ	W / m2K	0,413		0,413	
	Glazing	U,	W / m2K	2,50		2.50	$\vdash$
					0.500	A,00	┣──┤
	Average U-value	Uav	W / m2K	0,710	0,500		┣──┤
	Glazing	9	total solar energy transmittance of glazing [%]	76			$\vdash$
	Shading	Fs	Shading correction factor	61	<u> </u>	0.000	┢──┤
	Ventilation rate [4	÷	air changes/hr	0,609	<u> </u>	0,609	╞━━━┿
2	Building Energy			_			
2.1		per m2 of t	otal used conditioned floor area (kWh / m2vr)	incl. system losse			+
energy carrier	suggested			Estation	National	suggested	N Farmer
existing building	energy carrier		specify energy efficiency measures [13]	Existing building [5]	regulation-BBR19 (2012)* [6]	specification	% Energy savings [8]
building	camer		specify energy enciency measures [13]	Duilding [5]	(2012)* [6]	[7]	savings (8)
leating							
		-	Thermal photography, air tightness test and	157		33	
district heating	district heating	kWh/m <sup>2</sup> yr	tightning measures , additional insulation of	157		33	I
			attic joists etc, optimization of heating	total distr.heating			
entilation			system, ref. temp in each apartment	1			
			Air handling units with supply and exhaust air,		<u> </u>	21	
district heating	district heating	kWh/m²yr	and energy recovery				
omestic Hot V	Vater (DHW)						
district heating	district heating	kWh/m <sup>2</sup> yr	Water and energy saving taps and showers			21	75
ther energy d						8	otal distr.heating
ther energy a	emand			-			$\rightarrow$
	1 1		Electricity to the building, (fans, pumps,	16		11	I
electricity	electricity	kWh/m²yr	etc.)		<u> </u>		
		kWh/m <sup>2</sup> yr		173	90	86	
	Appliances (pla:		but costs are not eligible)				
	Appliances (pic	ase indicane,	Class A++ or A+ Appliances, LED ligth,	<b>i i</b>	<u> </u>		<del></del>
	1 1		Meagsuring and Behaviour changing	1 1		1 1	I
	electricity	kWh/m <sup>2</sup> yr	solutions	46		22	28
		Kriten y	andona	-10			20
	Food						
			Solutions for lowering food waste and				
		Co2/m <sup>2</sup> yr	promoting change of diet	67		57	15
	Avoided emissi	ons in socie	ty				
			Decreased emisions from waste and water				<u> </u>
		Co2/m <sup>2</sup> yr	treatment				0
		kWh/m <sup>2</sup> yr		46	0	33	28
		CO2/m <sup>2</sup> yr		40	0	57	40
	DEP DURING		and the stimule are set if and the tool second second in the		0	31	15
2,2			ontribution per m2 of total used conditioned a biomass (=RES) and 5% fossil fuel	rea (Kwn / mz yr)			++
	district heating in		promass (=PCE3) and 3% 1055il Tuel		National	suggested	RES
stal production		kW		Existing	regulation-88R19	specification	contribution
kWh/yr	m <sup>2</sup> installed	installed	specify RES measures	building [5]	(2012)* [6]	. 17	[%][8]
45000	150	104	Solar collectors to make hot water -PVT	0		22	
19500	-	-	Solar collectors to make electricity - PVT	0		10	
15353	n.a.	n.a.	Waste water heat pump	0		8	
10000							
10000							
10000							

			n Table (BEST)	1			
1,1	Building Catego		*	total area / catego	ry / BEST sheet [2]	3340 m	2
		[1	Kv. Tvinnaren 4-Växjö				
1,2	Local Climate			January average	outside temperature	°C	-0,9
				August average o	utside temperature	°C	17,3
	Climatic Zone			Average global ho	prizontal radiation	kWh/m <sup>2</sup> yr	942
	(national definitio	in)	zone 3 - southern Sweden	Annual heating de	egree days [3]	°Cd/yr	3787
				Room temperature	e	°C	20
				Existing	National	suggested	
				building	regulation-BBR19	specification	Energy savings
1,3	Maximum requi	irements of bu	ilding fabric	[5]	(2012)* [6]	[7]	[%] [8]
	Façade/wall	U	W / m2K	0,35		0,35	
	Roof	U	W / m2K	0,5		0,25	50
	Ground floor	U	W / m2K				
	Glazing	Ug	W / m2K	3,00		1,00	67
	Average U-value		W / m2K				
	Glazing	g	total solar energy transmittance of glazing [%]				
	Shading	Fs	Shading correction factor	4		6.0	55
	Ventilation rate	[4]	m3/s (max air flow)	4		5,8	55
2	Building Energy	Performance	2				
2,1	Energy demand	per m2 of tot	al used conditioned floor area (kWh / m2yr) in	icl. system losses			
energy					National	suggested	
carrier	suggested			Existing	regulation-BBR19	specification	% Energy
existing	energy carrier		specify energy efficiency measures [13]	building [5]	(2012)* [6]	[7]	savings [8]
eating + ver	ntilation + DHW +	building elect	ricity				
			New ventilation unit with heat recovery,				
			mounting of triple glass windows, insulation in	1 1		1 1	
			roof, installation of combined district heating	93		52	
			and cooling central, reduction of water circuits	93		52	44
district			and tuning, waste heat from personnel	1 1		1 1	
heating	district heating	kWh/m <sup>2</sup> yr					
ooling							
electric	district cooling	kWh/m <sup>2</sup> vr	Conversion to district cooling	10	<u> </u>	21	n.a
ghting				-			
electric	electric	kWh/m <sup>2</sup> yr	Exchange of lighting to LED-lighting	21	i i	4	82
ther energy	demand						
uner energy	demand	1000.1-2		<u> </u>	<u> </u>	<u> </u>	
_		kWh/m <sup>2</sup> yr					
		kWh/m <sup>2</sup> yr		124	90	77	38
	Appliances (plea	ase indicate, bu	it costs are not eligible)	1 1			
	-	kWh/m <sup>2</sup> yr		<u> </u>	<u> </u>	<u> </u>	-
2,2	RES /building in		tribution per m2 of total used conditioned are	a (kWb ( m2 ur)			
2,2			iomass (=RES) and 5% fossil fuel	a (Kwii / inż yr)			
total	uisinci neaung in	value 15 80 /8 E	ionass (=RE3) and 5% lossifider		National	suggested	
production		kW		Existing	regulation-BBR19	specification	RES contribution
kWh/yr	m <sup>2</sup> installed	installed	specify RES measures	building [5]	(2012)* [6]	[7]	[%][8]
91100	561	107,4	PV-system	0		26	100
87100	573	109,7	PV-system (option)	0		27	100
_	<b>—</b>						

Building Ener	rgy Specificati	ion Table				BEST no.	SE1
			Community / site	Växjö	Sweden	J	
1,1	Building Category		residential retrofited	total area / cate	gory / BEST sheet [2]	m <sup>2</sup> Gross area	8
			[1] Kv.Alabastem-Växjö				
1,2	Local Climate			January average	e outside temperature	°C	
				August average	outside temperature	*C	
	Climatic Zone			Average global	horizontal radiation	kWh/m <sup>2</sup> yr	
	(national definition)		zone 3 - southern Sweden	Annual heating of	degree days [3]	°Cdlyr	3
				Room temperat	ure	°C	
					NEW EXTE		
				Kv.	Alabastern	8059	
1,3	Maximum requirem	ents of building	fabric			87	
				Existing building (5)	BBR19 (2012)* [6]	suggested specification [7]	Energy savings [%]
	Facade/wall	U	W / m2K	0,36	DBI(TD (LDTL)  0	0,36	Serings [10]
	Roof	Ŭ	W/m2K	0,236		0,073	69
	Ground floor	U	W / m2K	0,413		0,413	
	Glazing	Ug	W / m2K	2,50		0,90	64
	Average U-value	U.,	W / m2K	0,710	0,500	0,475	33
	Glazing	g	total solar energy transmittance of glazing [%]	76		46	
	Shading	Fs	Shading correction factor	61		36	L
	Ventilation rate	[4]	air changes/hr	0,609		0,609	L
2,1 energy carrier existing building Heating	Energy demand pe suggested energy carrier	r m2 of total us	d conditioned floor area (kWh / m2yr) incl. system losses specify energy efficiency measures [13]	[5] total distr.heatin	BBR19 (2012)* [6]	specification [7]	savings (
district heating	district heating	kWh/m <sup>2</sup> y	Additional insulation of attic joists. Replacement of windows	149		25	
Ventilation	0.00.000.0000.000	,					·
district heating	district heating	kWh/m <sup>2</sup> y	Air handling units with supply and exhaust air, and energy recovery			21	
Domestic Hot Water	,						·
district heating	district heating	kWh/m <sup>2</sup> y	Individual measurement of cold and hot water.		1	21	total distr.b
Other energy deman		Kaynim y	Individual measurement of cold and not water,				33
	-				•		
electricity	electricity	kWh/m <sup>2</sup> y	Electricity to the building, (fans, pumps, etc.)	11		8	27
Crock Kity							
C COM KITY		kWh/m <sup>2</sup> y		160	90	75	53
cicoticity	Appliances (please	kWh/m <sup>2</sup> y		160	90	75	53
	Appliances (please electricity	kWh/m <sup>2</sup> y	Class A++ or A+ Appliances, LED ligth, Meaqsuring and Behaviour	4		75	
cica aty		kWh/m <sup>2</sup> y indicate, but co	Class A++ or A+ Appliances, LED ligth, Meaqsuring and Behaviour		5		3
2,2	electricity	KWIt/m <sup>2</sup> yi indicate, but cos kWIt/m <sup>2</sup> yi KWIt/m <sup>2</sup> yi	Class A++ or A+ Appliances, LED ligth, Meaqsuring and Behaviour	46	5	33	3
2,2	electricity RES (building integ	KWh/m <sup>2</sup> yi indicate, but cos kWh/m <sup>2</sup> yi KWh/m <sup>2</sup> yi	Class A++ or A+ Appliances, LED ligth, Meaqsuring and Behaviour changing solutions	4	8	33	99
	electricity RES (building integ	KWh/m <sup>2</sup> yi indicate, but cos kWh/m <sup>2</sup> yi KWh/m <sup>2</sup> yi	Class A++ or A+ Appliances, LED ligth, Meaqsuring and Behaviour changing solutions	4	5	33	RES
2,2 total production	electricity RES (building integ district heating in Va	KWh/m <sup>2</sup> yi indicate, but cos kWh/m <sup>2</sup> yi KWh/m <sup>2</sup> yi grated) contribu gio is 95% biom KW	Class A++ or A+ Appliances, LED ligth, Meaqsuring and Behaviour changing solutions ion per m2 of total used conditioned area (kWh / m2 yr) ss (~RES) and 5% fossil fuel	44	s 8 () 9 National regulation-	33 33 suggested	RES

rannanng Ener	rgy Specificatio	IT TADIE (DE					BEST no.	SE1.1
			Community / site		Vâxijó	Sweden		
1,1	Building Category		residential retrofitted		total area /	category / BEST sheet [2]	m <sup>2</sup> Gross area	1
			1 NV.Avabastem-Vaxjo					
1.2	Local Climate				January av	erage outside temperature	°C	
					August ave	rage outside temperature	°C	1
	Climatic Zone					obal horizontal radiation	kWh/m <sup>2</sup> yr	
	(national definition)		zone 3 - southern Sweden			ting degree days [3]	°Cd/yr	3
			-		Room temp		°C	
								0.54
						NEW EXT	ENTION	SE1.
						Ky.Alabastern	1891	m2 E
1,3	Maximum requirement	nts of building fab	ric				18	
					Existing but	kling National regulation-	suggested	Energy saving
					[5]	BBR19 (2012)* [6]	specification [7]	
	Façade/wall	U	W / m2K		0,36		0,36	
	Roof	U	W/m2K		0,236		0,073	69
	Ground floor	U	W / m2K		0,413		0,413	
	Glazing	Ua	W / m2K		2,50		0,90	64
	Average U-value	U.,	W / m2K		0,710	0,500	0,475	33
	Glazing	q	total solar energy transmittance or	elazina ISCI	76	0,000	46	33
	Shading	Fs	Shading correction factor	spacing [70]	61		36	
	Ventilation rate	[4]	air changes/hr		0,609		0,609	
	Verbiedurtrane	P1	an changeann		0,003		0,003	
energy carrier existing building eating	suggested energy carrier		specify energy efficiency measure	es [13]	total distr.h	eating		
district heating	district heating	kWh/m <sup>2</sup> yr	Additional insulation of attic joists	Replacement of windows	149		25	
entilation								
district heating	district heating	kWh/m <sup>2</sup> yr	Air handling units with supply and	exhaust air, and energy recovery			21	
omestic Hot Water	-	, Arrivin ji						
unicade mot trater	(Drive)							
								total distr.hea
district heating	district heating	kWh/m²yr	Individual measurement of cold a	nd hot water,				total distr.hea 55
		kWh/m²yr	Individual measurement of cold a	nd hot water,				
		kWh/m²yr kWh/m²yr	Individual measurement of cold a		11			
ther energy deman	nd				11	90	21	
ther energy deman	electricity	kWh/m²yr kWh/m²yr	Electricity to the building, (fans, pr			90	21	55 27
ther energy deman	nd	kWh/m²yr kWh/m²yr	Electricity to the building, (fans, pr	imps, efc.)		90	21	55 27
ther energy deman	electricity	kWh/m²yr kWh/m²yr	Electricity to the building, (fans, pr	imps, efc.)		46	21	55 27
ther energy deman	electricity Appliances (please in	kWh/m <sup>2</sup> yr kWh/m <sup>2</sup> yr dicate, but costs a	Electricity to the building, (fans, p re not eligible) Class A++ or A+ Appliances, LEC	imps, efc.)		46	21 8 75	55 27
ther energy deman	electricity Appliances (please in	kWh/m <sup>2</sup> yr kWh/m <sup>2</sup> yr dicate, but costs a	Electricity to the building, (fans, p re not eligible) Class A++ or A+ Appliances, LEC	imps, efc.)			21 8 75	55 27
ther energy deman	d electricity Appliances (please in electricity RES (building integra	kWh/m²yr kWh/m²yr dicate, but costs a kWh/m²yr kWh/m²yr ated) contribution	Electricity to the building, (fans, pr enoteligible) Class A++ or A+ Appliances, LEE changing solutions	imps, etc.) 2 ligth, Meaquuring and Behaviour		46	21 8 75 33	55 27
ther energy deman electricity 2.2	d electricity Appliances (please in electricity RES (building integra	kWh/m²yr kWh/m²yr dicate, but costs a kWh/m²yr kWh/m²yr ated) contribution	Electricity to the building, (fans, pr en not eligible) Class A++ or A+ Applances, LEC changing solutions	imps, etc.) 2 ligth, Meaquuring and Behaviour	160	46 46	21 8 75 33 0 33	55 27 53
ther energy deman electricity 2.2 total production	d electricity Appliances (please in electricity RES (building integro district healing in Vaci	KWH/m²yr KWH/m²yr dicate, but costs a KWH/m²yr KWH/m²yr ated) contribution o is 95% biomass	Electricity to the building, (fare, pr re not eligible) Class A+ or A+ Appliances, LEC changing solutions per m2 of total used conditioned at (=RES) and 5% fossil fuel	imps, etc.) 2 ligth, Meaquuring and Behaviour	Existing bui	46 46 kling National regulation-	21 8 75 33 0 33 suggested	55 27 53 RES contribu
electricity electricity 2.2 total production KMNyr	d electricity Appliances (please in electricity RES (building integro district healing in Vaaj m <sup>2</sup> installed	KWH/m²yr KWH/m²yr dicate, but costs a KWH/m²yr KWH/m²yr ated) contribution 5 is 95% biomass KW installed	Electricity to the builting, (fare, pr e not aligible) Class A++ or A+ Appliances, LEC changing solutions per m2 of total used conditioned at (=RES) and 5% fossil fuel specify RES measures	mps, etc.) ) ligth, Meaqsuring and Behaviour rea (kWh / m2 yr)	Existing bui	46 46	21 8 75 33 0 33 suggested specification [7]	55 27 53
ther energy deman electricity 2.2 total production KNNiyr 45000	d electricity Appliances (please in electricity RES (building integro district healing in Vaci	KWH/m²yr KWH/m²yr dicate, but costs a KWH/m²yr KWH/m²yr ated) contribution 5 is 95% biomass KW installed	Electricity to the building, (fare, pr re not eligible) Class A+ or A+ Applances, LEC changing solutions per m2 of total used conditioned an arRES) and 5% fossil fuel specify RES measures Solar collectors to make hot wate	mps, etc.) I igth, Meaqsuring and Behaviour rea (kWh / m2 yr) r-PVT	Existing bui	46 46 kling National regulation-	21 8 75 33 0 33 suggested specification [7] 24	55 27 53 RES contribu
ther energy deman electricity 2.2 total production KMNyr	d electricity Appliances (please in electricity RES (building integro district healing in Vaaj m <sup>2</sup> installed	KWH/m²yr KWH/m²yr dicate, but costs a KWH/m²yr KWH/m²yr ated) contribution 5 is 95% biomass KW installed	Electricity to the builting, (fare, pr e not aligible) Class A++ or A+ Appliances, LEC changing solutions per m2 of total used conditioned at (=RES) and 5% fossil fuel specify RES measures	mps, etc.) I igth, Meaqsuring and Behaviour rea (kWh / m2 yr) r-PVT	Existing bui	46 46 kling National regulation-	21 8 75 33 0 33 suggested specification [7]	55 27 53 RES contribu
her energy deman electricity 2.2 total production KNNiyrr 45000	d electricity Appliances (please in electricity RES (building integro district healing in Vaaj m <sup>2</sup> installed	KWH/m²yr KWH/m²yr dicate, but costs a KWH/m²yr KWH/m²yr ated) contribution 5 is 95% biomass KW installed	Electricity to the building, (fare, pr re not eligible) Class A+ or A+ Applances, LEC changing solutions per m2 of total used conditioned an arRES) and 5% fossil fuel specify RES measures Solar collectors to make hot wate	mps, etc.) I igth, Meaqsuring and Behaviour rea (kWh / m2 yr) r-PVT	Existing bui	46 46 kling National regulation-	21 8 75 33 0 33 suggested specification [7] 24	55 27 53 RES contribu