
CitiEnGov Final conference
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# Low carbon public buildings-targets and challenges up to 2050

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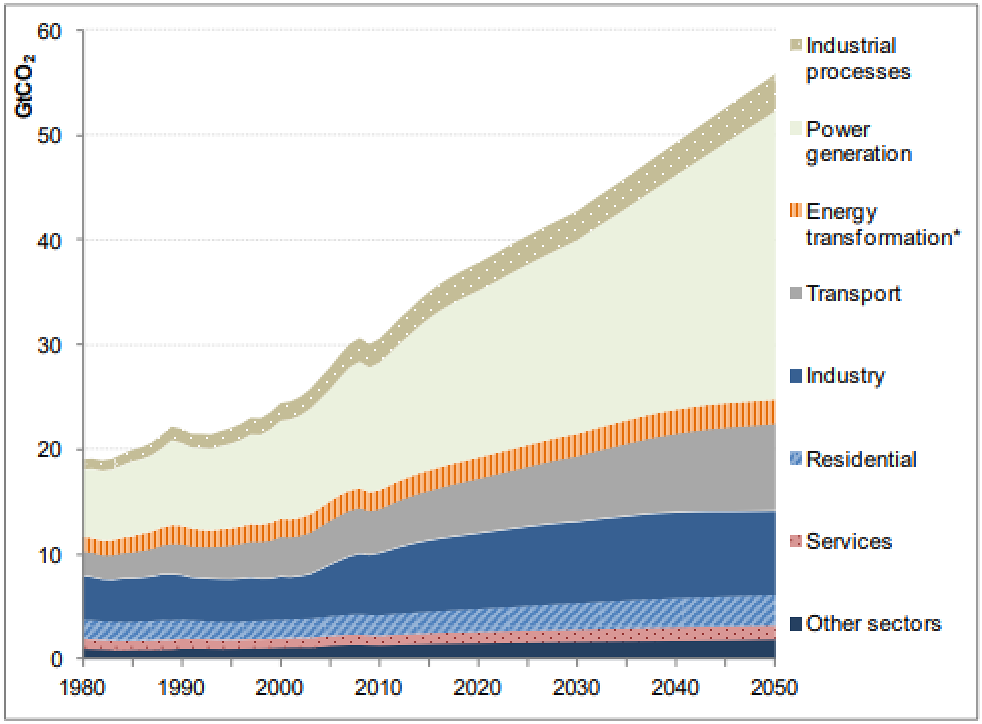
# INTRODUCTION – $CO_2$ EMMISION FORECAST UP TO YEAR 2050

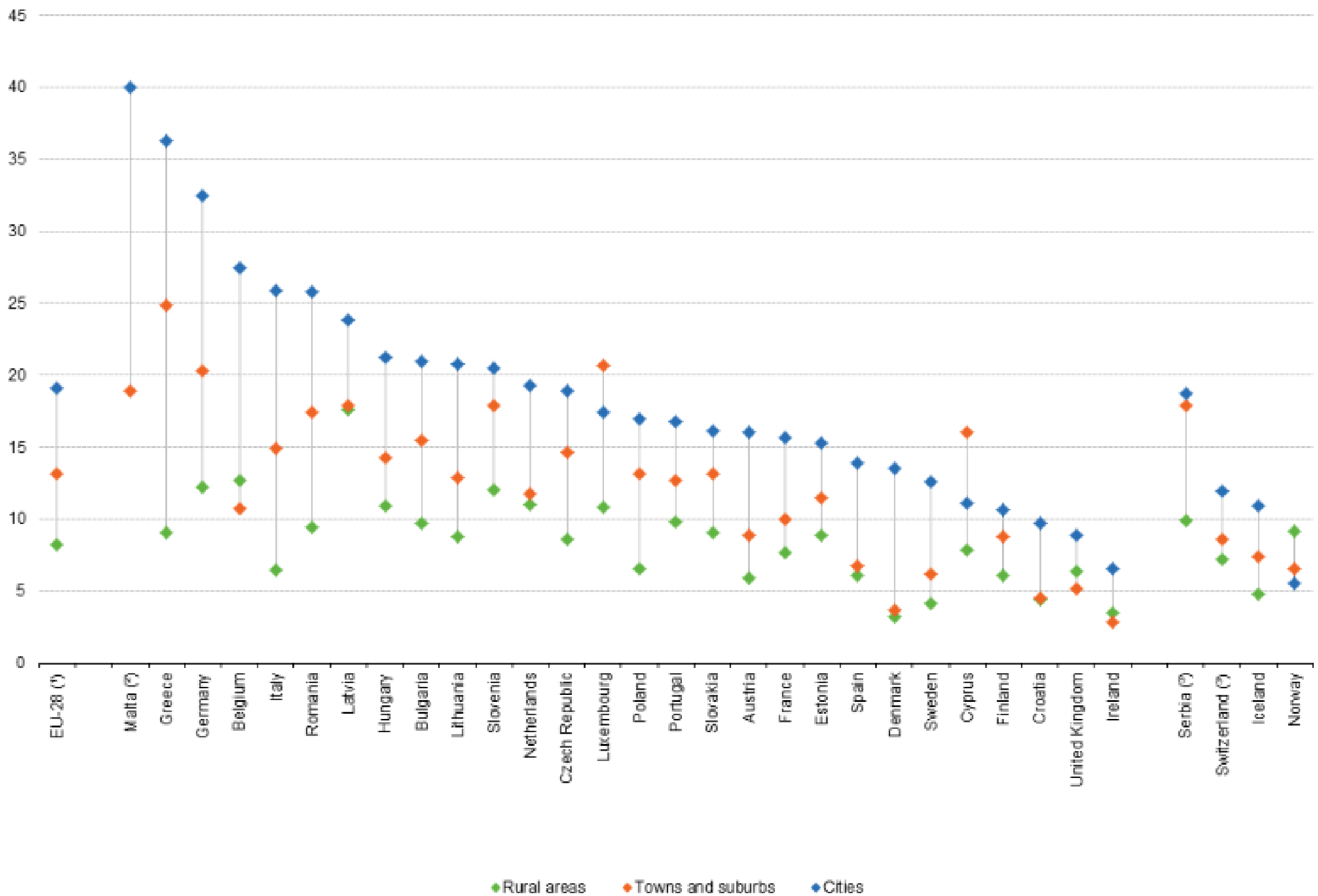



Note: The category "energy transformation" includes emissions from oil refineries, coal and gas liquefaction.

*Source: OECD Environmental Outlook Baseline;* output from IMAGE.

**Graph1** *Structure of $CO_2$ emmisions in period from 1980 to 2010 and forecast up to 2050 (Source: OECD)*

# ENVIRONMENTAL IMPACT




Graph2 Pollution exposure and level of urbanisation in *EU countries*

# THE PUBLIC BUILDINGS CHALLENGE - ENERGY EFFICIENCY EU REQUIREMENTS FULLFILMENT UP TO 2050

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Public building energy efficiency compliance to achieve the EU 2050 requirements (zero $CO_2$ emmisions)

New buildings

Old buildings

New tehnical requirements; almost ˝passive buildings˝ regarding energy energy efficiency

Energy efficiency improvements criteria; as much as possible

Renewable energy sources in central heating, ventilation and air conditioning (HVAC)

PHASE 1

Renewable energy sources in el.energy generation

PHASE 2

# RENEWABLE ENERGY SOURCES (RES) AND LOW TEMPERAURE HEATING (LTH)

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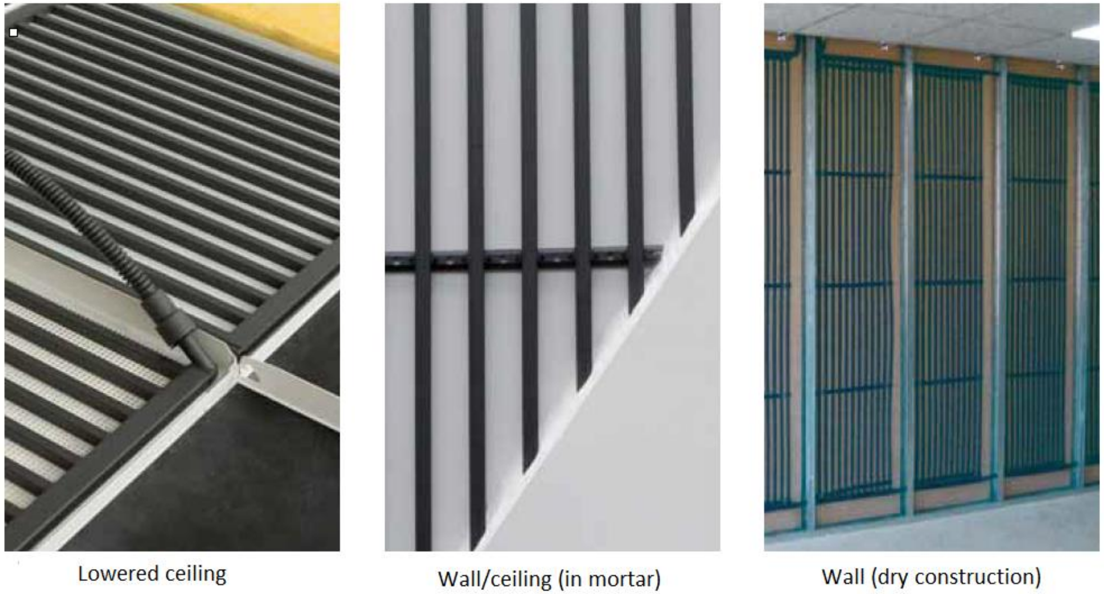
The actual design methods for heating systems are based on the utilisation of the huge temperature drop. Renewable Energy Sources (RES) provide much smaller temperature interval operating at significantly lower temperatures. Wall and floor heating systems fit specific well into a LTH design. Also, air heating, enlarged radiators and convectors can be applied.




***Picture 1,2,3*** Elements of Low Temperature Heating (LTH)

# RENEWABLE ENERGY SOURCES PERSPECTIVE

## The EMERSON SG company statement:

˝ By replacing the traditional solution of central heating, fossil fuel boilers and air conditioning systems, heat pumps for central heating and air conditioning, 40-50% of energy savings are achieved.˝

https://climate.emerson.com/en-us/industries/processing

# RES IN PUBLIC BUILDINGS

| ENERGY CONSUMPTION | HEAVY OIL BOILERS (CURRENT SOLUTION) | HEAT PUMPS | BIOMASS BOILERS | NATURAL GAS BOILERS |
|---|---|---|---|---|
| Fuel net (kWh/god.) | 5.607.490 | 5.607.490 | 5.607.490 | 5.607.490 |
| Heat losses of the source (kWh/year) | 785.049 | 0 | 504.674 | 448.599 |
| Heat transfer losses (kWh/year) | 560.749 | 0 | 0 | 0 |
| El.energy (kWh/year) | 1.604.000 | 1.393.760 | 1.604.000 | 1.604.000 |
| El.energy generated (kWh/year) | 0 | 0 | -1.728.000 | 0 |
| Water (m3/year) | 117.000 | 110.000 | 117.000 | 117.000 |
| **YEARLY ENERGY COST (A)** | **7.471.200 kn** | **3.706.132 kn** | **4.448.615 kn** | **5.515.159 kn** |
| Fuel net (a) | 3.575.000 kn | 841.124 kn | 1.233.648 kn | 2.186.921 kn |
| Heat losses of the source (b) | 500.500 kn | 0 kn | 61.682 kn | 174.954 kn |
| Heat transfer losses (c) | 357.500 kn | 0 kn | 0 kn | 0 kn |
| **Total fuel cost (a+b+c)** | **4.433.000 kn** | **841.124 kn** | **1.295.330 kn** | **2.361.875 kn** |
| El.energy consumed | 1.283.200 kn | 1.215.008 kn | 1.398.284 kn | 1.398.284 kn |
| El.energy generated (kWh/year) | 0 kn | 0 kn | 0 kn | 0 kn |
| Water (m3/year) | 1.755.000 kn | 1.650.000 kn | 1.755.000 kn | 1.755.000 kn |
| **TOTAL (A):** | **7.471.200 kn** | **3.706.132 kn** | **4.448.615 kn** | **5.515.159 kn** |
| **MANPOWER COST (B)** | 744.049 kn | 0 kn | 0 kn | 0 kn |
| **TOTAL YEARLY COSTS (A+B)** | 8.215.249 kn | 3.706.132 kn | 4.448.615 kn | 5.515.159 |
| | | | | |
| **SAVINGS** | **0 kn** | **4.509.118 kn** | **3.766.634 kn** | **2.700.090 kn** |
| | | | | |
| **SAVINGS BALANCE SHEET** | | **HEAT PUMP** | **BIOMASS** | **NATURAL GAS** |
| Investment cost | | 9.000.000 kn | 12.600.000 kn | 4.500.000 kn |
| Yearly energy costs | | 3.706.132 kn | 4.448.615 kn | 5.515.159 kn |
| Yearly maintenance cost | | 100.000 kn | 110.000 kn | 100.000 kn |
| Yearly savings | | 4.509.118 kn | 3.766.634 kn | 2.700.090 kn |
| Return on investment (year) | | 2,9 | 4,7 | 3,8 |

***Table 1*** Potential solutions of central heating/air conditioning system upgrade in public biulding with high energy demand (1EUR=7,5kn)

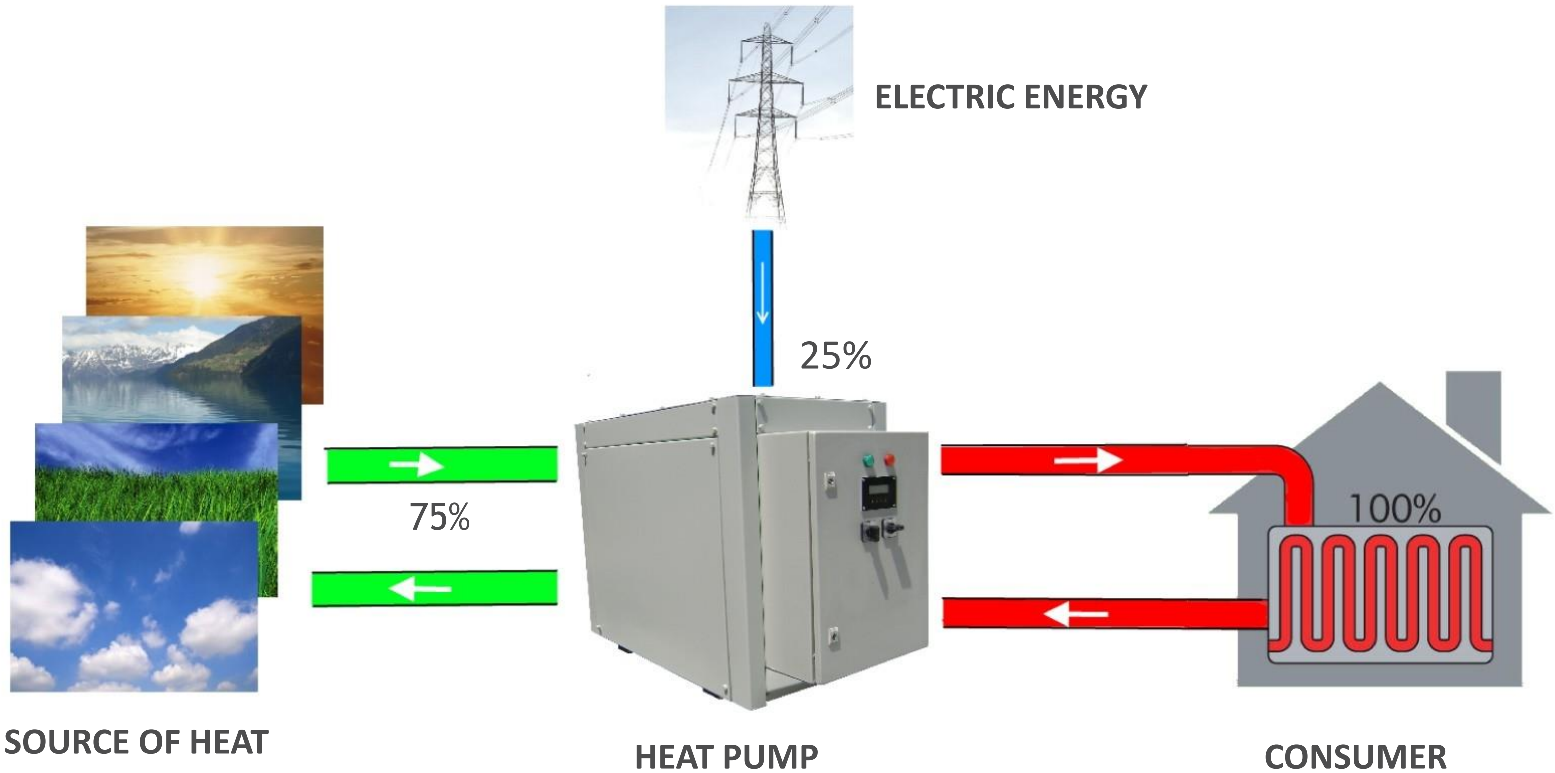
# RES IN PUBLIC BUILDINGS

| CENTRAL HEATING AND CLIMATISATION | CURRENT CONDITION | NEW |
|---|---|---|
| Central heating and climatisatin solution | Fosil fuel | Renewable sources of energy, waste heat recovery |
| Energy consumption (MWh/year) | 12,1* | 6,8 |
| Heat unitary price (€/kWh) | 0,04 | **0,018** |
| Energy savings (kWh/year) | - | **5.300.000** |
| Savings (€/year) | - | **220.000** |
| Return on investment | | **3,3 years** |

**Table2** *Comparison of fosil fuel and heat pumps based RES solution of central heating and air conditioning for a building with high energy demands in Zagreb, Croatia*

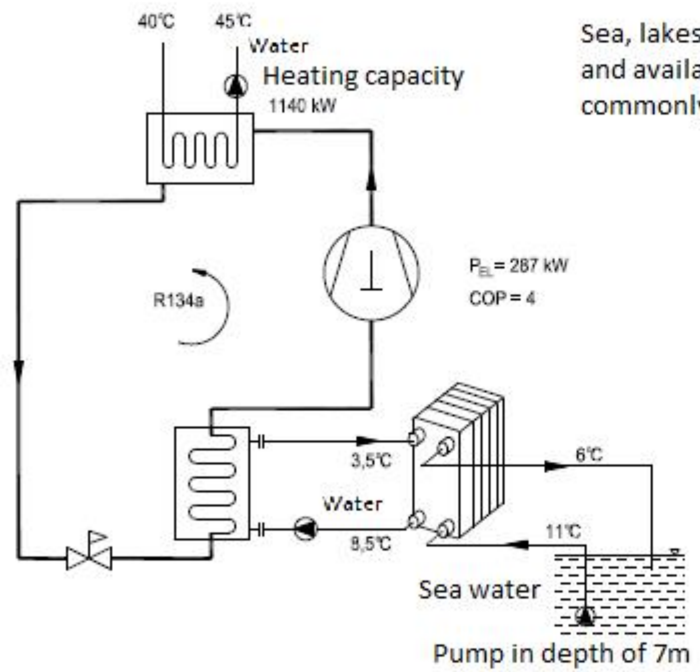
# HEAT PUMPS TECHNOLOGY PRINCIPLE

## DIZALICE TOPLINE




***Scheme 1*** *Heat pumps principle with different source/sink of heat opportunities*

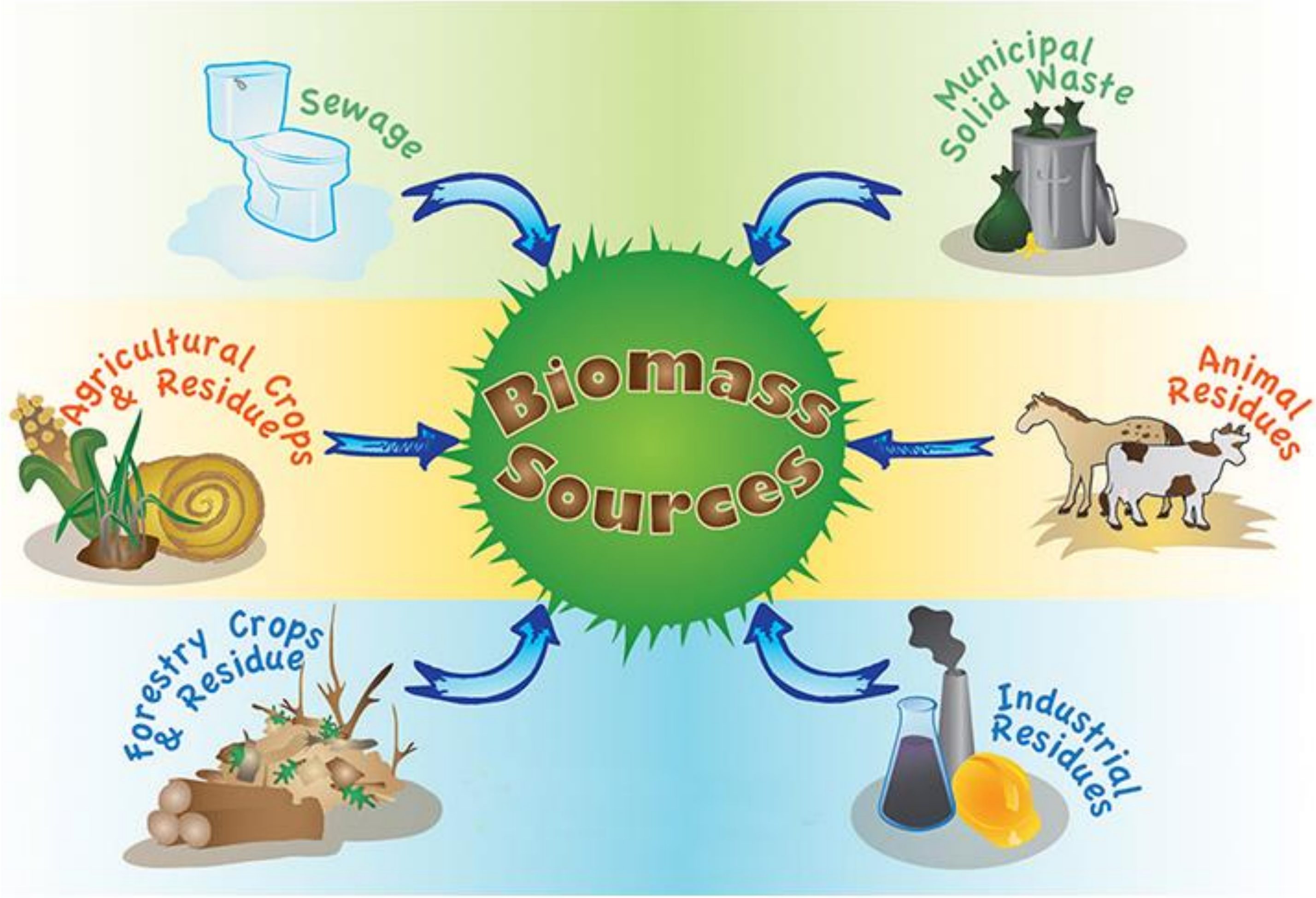
# HEAT PUMPS SOLUTIONS OF HEATING/AIR CONDITIONING IN PUBLIC BUILDINGS




Sea, lakes and rivers nearby settlements have cheap and available source of heat. That kind of water are commonly used at temperatures above +4°C.

***Scheme 2** Heat pumps HVAC system using sea water as source/sink of heat provides energy and cost efficient solution of heating/air conditioning*

# BIOMASS SOURCES




***Picture 4** Scope of biomass sources*

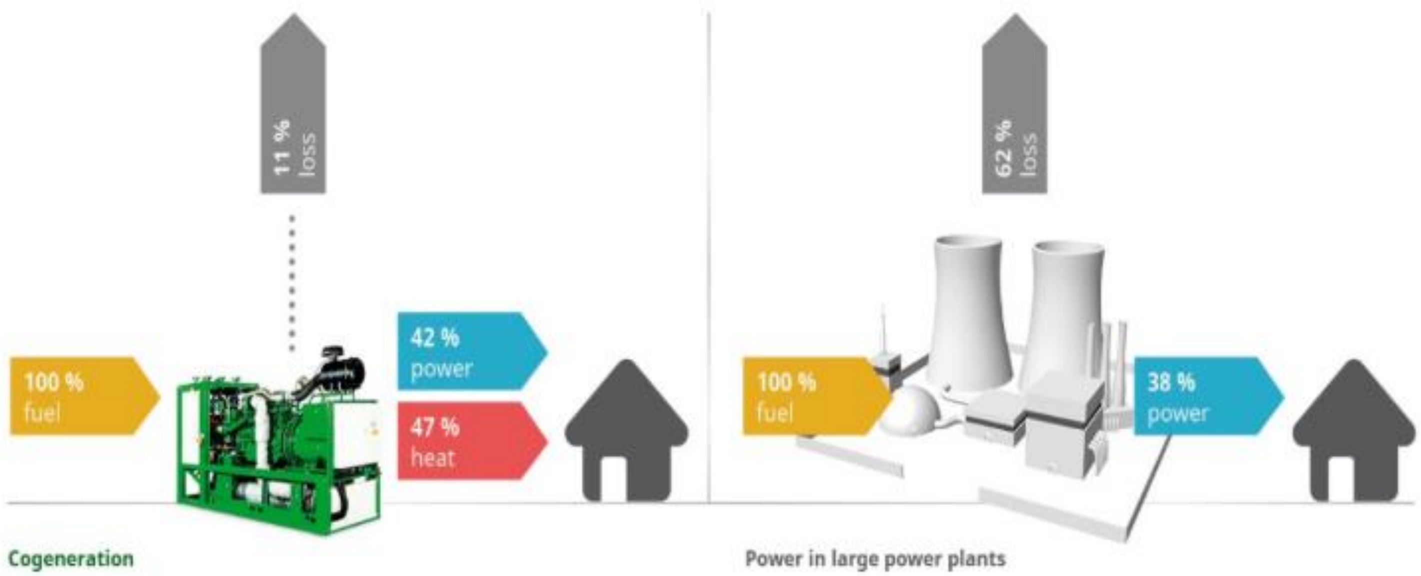
# BIOMASS THERMAL ENERGY SOLUTIONS



Biomass boilers design is more complex and it requires much more space comparing to the fosil fuels ones and heat pumps so it significantly increase Investment costs of biomass central heating solution.
Biomass thermal energy cost is lowest comparing to the fosil fuel and heat pump solutions in areas within 100km from the source.

***Picture 5,6,7*** *Hot water boile driven by biomass, firebox and biomass dosing system*

# COGENERATION IN PUBLIC BUILDING HEATING AND AIR CONDITIONING SOLUTIONS




*Scheme 3* Cogeneration of electrical and heat energy achieve higher efficiency (up to 89%) apart from big power plants el.energy production efficiency (up to 38%)

# WIND ENERGY TECHNOLOGIES IN RES OF PUBLIC BUILDING

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**Picture 8** *Micro windturbines integrated within the urban zone environment*

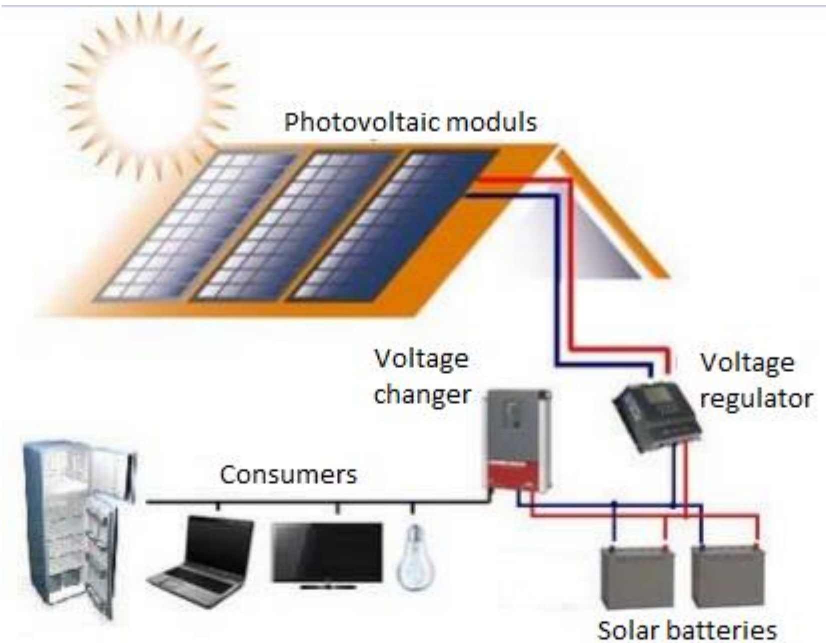
Wind energy technologies may be divided in two categories;

- ❖ Macro wind turbines used for big amount of energy generation in power plants,
- ❖ Micro wind turbines are used for local manufacturing of el.energy. They are suitable for buildings installing called ˝integrated windturbines˝. The main windturbine components are: blades, impeller, gearbox and generator.

Micro wind turbines may operate in following conditions:

- off-grid (independent grid),
- on-grid (conected with public grid).

# PHOTOVOLTAIC ENERGY MODULES IN RES OF PUBLIC BUILDINGS

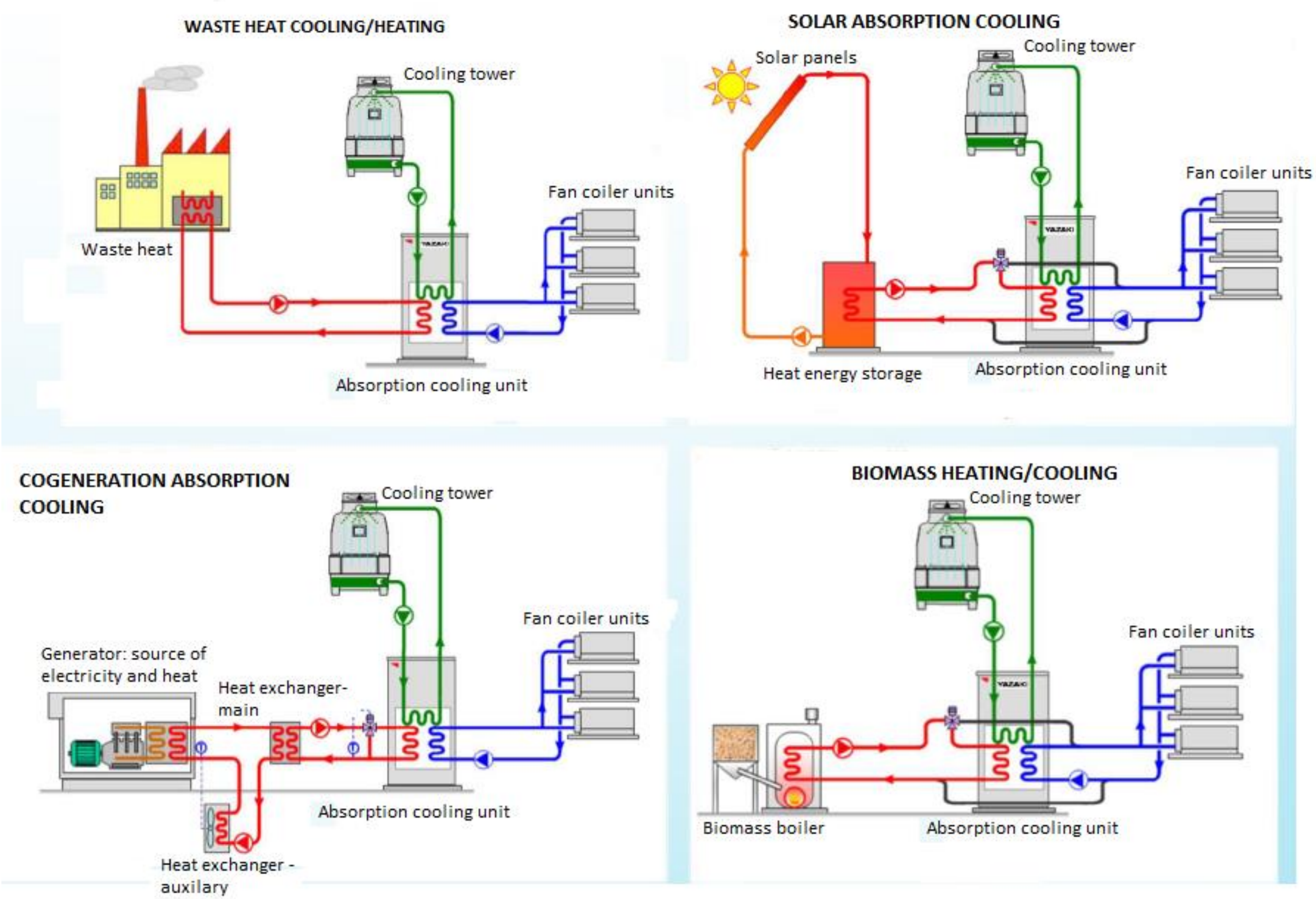



***Scheme 4** Photovoltaic off-grid system*

There are two basics types of photovoltaic energy generation in houses and buildings:

- ❖ The indipendent photovoltaic systems which can not operate on public grid (off-grid),
- ❖ The photovoltaic systems which may operate on public grid (on-grid).

# RES SOLUTIONS WITH ABSORPTION COOLING/HEATING UNITS




***Scheme 5*** Zero $CO_2$ emmision RES solution aplicable in public buildings

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