

SOLAR THERMAL POTENTIAL IN THE DISTRICT HEATING SYSTEM OF BELGRADE CITY

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DISTRICT ENERGY IN CITIES

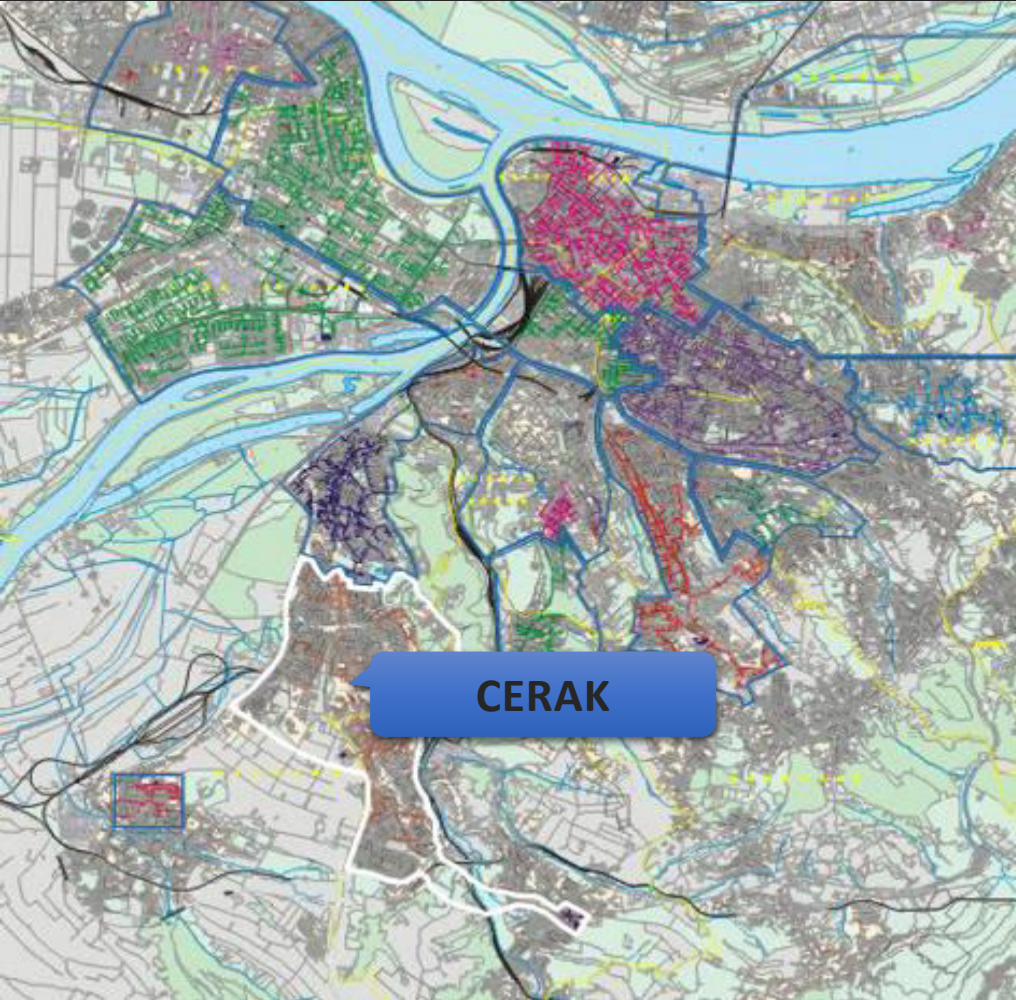
A GLOBAL INITIATIVE TO UNLOCK THE POTENTIAL OF ENERGY EFFICIENCY AND RENEWABLE ENERGY





STRUCTURE (%) OF RENEWABLE ENERGY POTENTIAL IN SERBIA

| Type of RES | Potential |
|-------------|-----------|
| Biomass | 63% |
| Solar | 14% |
| Wind | 4.5% |
| Geothermal | 4.5% |
| Hydro | 14% |



ASSESSMENT OF SOLAR THERMAL IN CERAK, BELGRADE

- **Cerak** is located in Belgrade's municipality of Čukarica;
- The population of more than **40,000 residents**;



CLIMATE DATA FOR BELGRADE

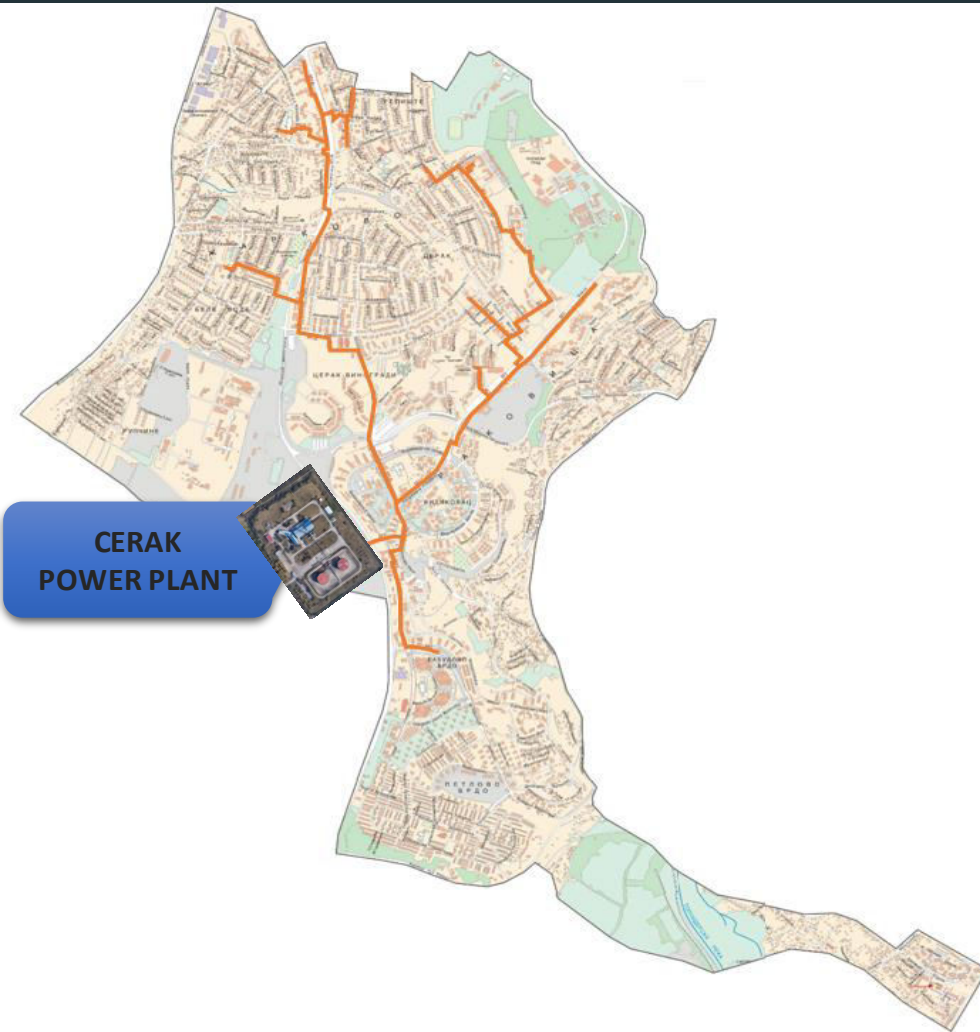
| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year |
|------------------------------------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|---------|
| Average high °C | 4.6 | 7.0 | 12.4 | 18.0 | 23.5 | 26.2 | 28.6 | 28.7 | 23.9 | 18.4 | 11.2 | 5.8 | 17.4 |
| Daily mean °C | 1.4 | 3.1 | 7.6 | 12.9 | 18.1 | 21.0 | 23.0 | 22.7 | 18.0 | 12.9 | 7.1 | 2.7 | 12.5 |
| Average low °C | -1.1 | -0.1 | 3.7 | 8.3 | 13.0 | 15.8 | 17.5 | 17.6 | 13.5 | 9.0 | 4.2 | 0.2 | 8.5 |
| Average snowy days | 10 | 7 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 8 | 33 |
| Mean monthly sunshine hours | 72.2 | 101.7 | 153.2 | 188.1 | 242.2 | 260.9 | 290.8 | 274.0 | 204.3 | 163.1 | 97.0 | 64.5 | 2,111.9 |



CERAK POWER PLANT

- **Cerak** power plant has been in operation **since 1985**;
- The **capacity** of **245 MW** (2x58 MW + 116 MW gas water boilers, 2x6.5 MW oil steam boilers);
- Due to a new connections there is a potential to **increase a future capacity**;
- Heat is supplied to **~27,000 apartments** (1,500,000 m²);
- Cerak heat plant has a **site** of about **76,000 m²**;





CERAK POWER PLANT

- **110 km** District Heating **Network** pipeline (Dn700/Dn600);
- Cerak heat plant has a **site** of about **75,900 m²**;



HEAT ENERGY DEMAND IN CERAК

| Date | Heat demand, MWh 2017 | Heat demand, MWh 2018 | Average heat demand, MWh 2017-2018 | Share from total heat demand in 2017-2018, % |
|--------------|--------------------------|--------------------------|---------------------------------------|---|
| Jan | 41,265 | 51,327 | 46,296 | 19.0 |
| Feb | 32,281 | 53,845 | 43,063 | 17.6 |
| Mar | 24,380 | 45,078 | 34,729 | 14.2 |
| Apr | 13,865 | 10,213 | 12,039 | 4.9 |
| May | 3,188 | 3,116 | 3,152 | 1.3 |
| Jun | 2,369 | 2,630 | 2,499 | 1.0 |
| Jul | 1,992 | 2,659 | 2,325 | 1.0 |
| Aug | 2,042 | 2,147 | 2,094 | 0.9 |
| Sep | 2,488 | 2,337 | 2,412 | 1.0 |
| Oct | 13,663 | 11,470 | 12,566 | 5.1 |
| Nov | 29,620 | 36,018 | 32,819 | 13.4 |
| Dec | 45,724 | 54,437 | 50,080 | 20.5 |
| Total | 212,877 | 275,283 | 244,080 | 100.0 |

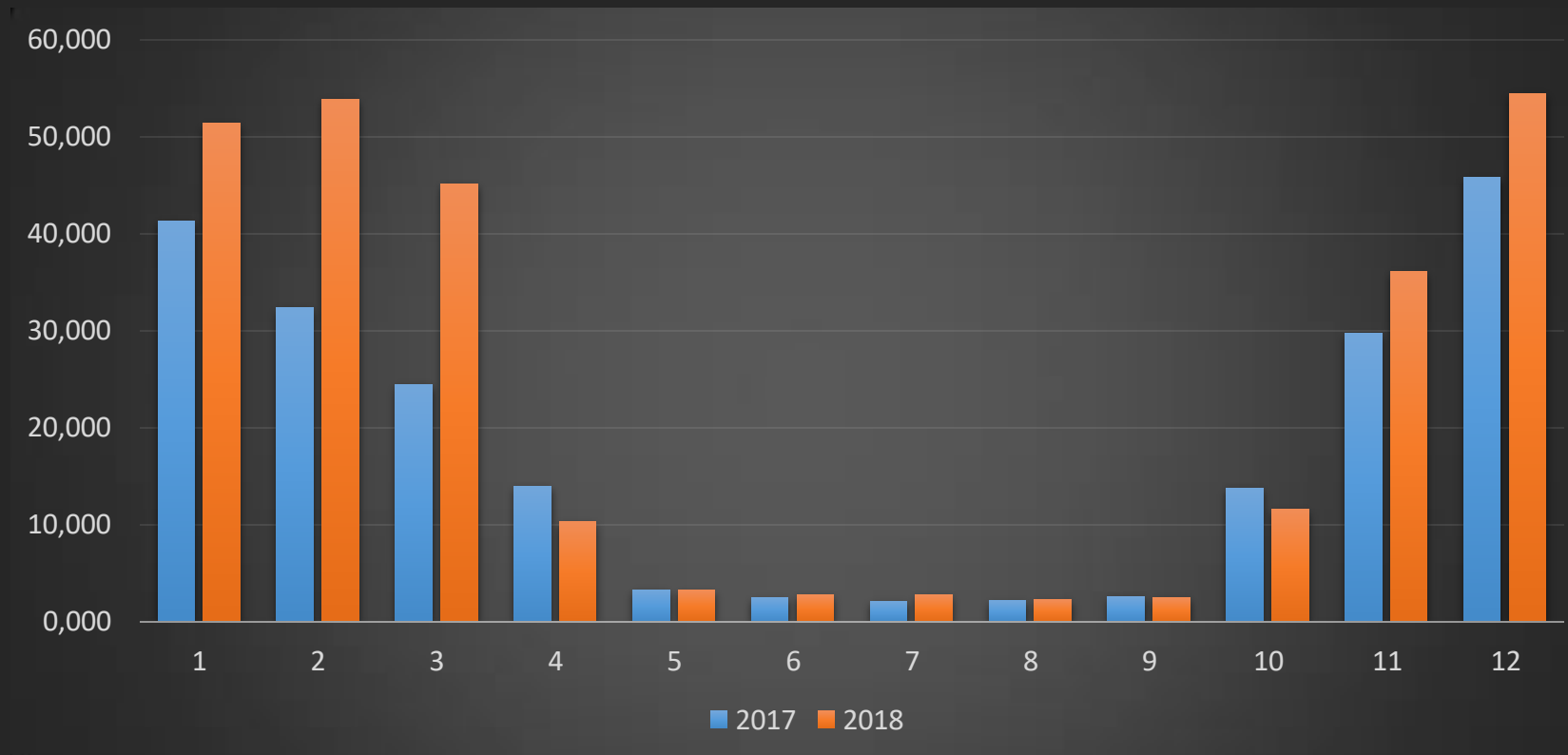




SOLAR THERMAL POTENTIAL IN BELGRADE DISTRICT HEATING SYSTEMS



HEAT ENERGY DEMAND IN CERAK

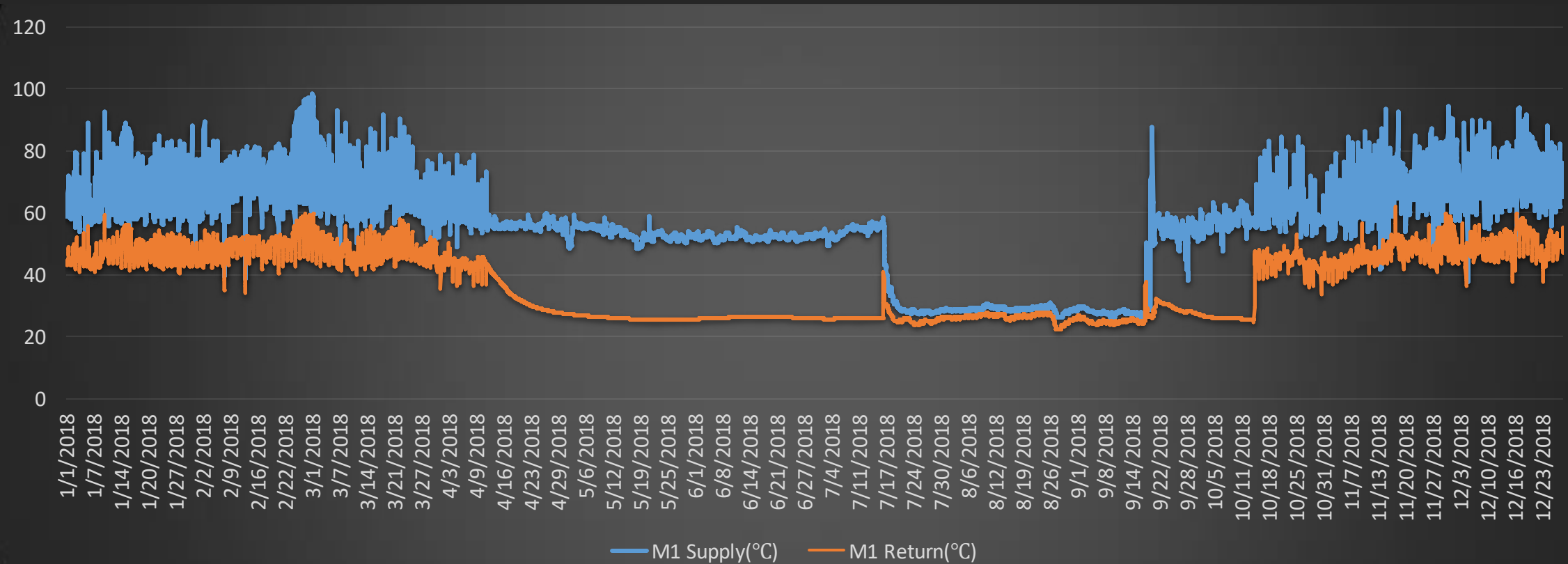




SOLAR THERMAL POTENTIAL IN BELGRADE DISTRICT HEATING SYSTEMS



DISTRICT HEATING NETWORK SUPPLY AND RETURN TEMPERATURES IN CERAК





HEAT DEMAND AND SOLAR HEAT PRODUCTION PER SOLAR THERMAL COLLECTOR AREA

| Date | Heat demand 2018, MWh | Heat product, KWh/m2 | 10,000 m2 | Heat product, MWh 31,800 m2 | 35,000 m2 | 39,700 m2 |
|--------------|--------------------------|-------------------------|--------------|--------------------------------|---------------|---------------|
| Jan | 51'327 | 16 | 163 | 518 | 570 | 647 |
| Feb | 53'846 | 31 | 312 | 992 | 1'092 | 1'239 |
| Mar | 45'079 | 45 | 447 | 1'420 | 1'563 | 1'773 |
| Apr | 10'214 | 51 | 506 | 1'609 | 1'771 | 2'008 |
| May | 3'117 | 72 | 719 | 2'286 | 2'516 | 2'853 |
| Jun | 2'631 | 79 | 786 | 2'500 | 2'752 | 3'121 |
| Jul | 2'659 | 81 | 805 | 2'559 | 2'816 | 3'194 |
| Aug | 2'148 | 78 | 780 | 2'481 | 2'731 | 3'098 |
| Sep | 2'338 | 57 | 574 | 1'825 | 2'009 | 2'279 |
| Oct | 11'470 | 41 | 411 | 1'308 | 1'439 | 1'633 |
| Nov | 36'019 | 23 | 229 | 728 | 802 | 909 |
| Dec | 54'438 | 16 | 155 | 492 | 542 | 614 |
| Total | 275'283 | 589 | 5'886 | 18'718 | 20'602 | 23'368 |

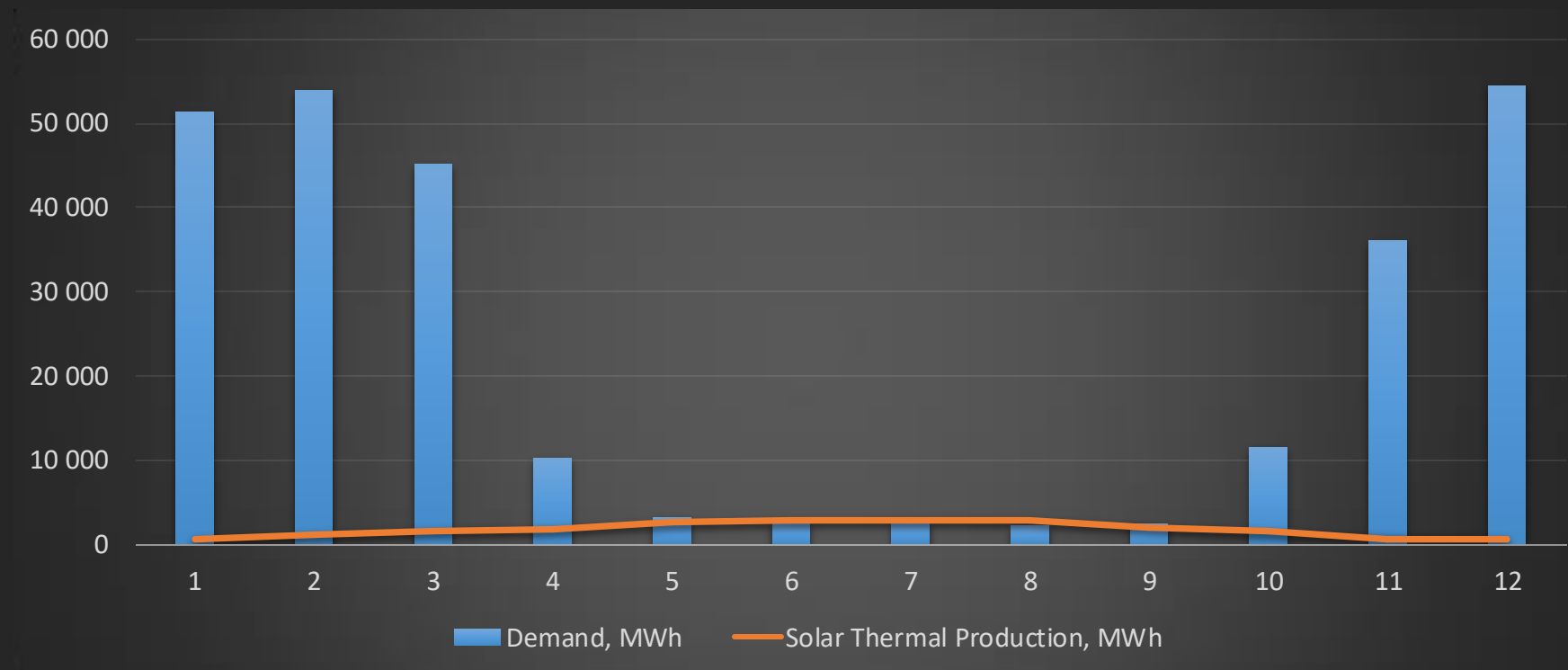




SOLAR THERMAL POTENTIAL IN BELGRADE DISTRICT HEATING SYSTEMS



HEAT DEMAND AND SOLAR HEAT PRODUCTION PER SOLAR THERMAL 35.000 m² COLLECTOR AREA





SOLAR THERMAL PANELS INSTALLATION

- The required **site area** for installation of **10,000 m²** of solar thermal collector panels is about **18,000 m²**,
- The solar thermal collector area of **35,000 m²** requires about **62,000 m²** of site area.

| Total solar collector area | 10,000 m ² | 35,000 m ² |
|----------------------------|-----------------------|-----------------------|
| Solar collector length | 5.97 m | 5.97 m |
| Row distance | 4 m | 4 m |
| Ground area | 23.88 m ² | 23.88 m ² |
| Required land area | 18,000 m ² | 62,000 m ² |



LAND AVAILABILITY IN CERAK POWER PLANT

- The **site area** of the **Cerak** heat plant is about **82,000 m²**;
- The area of the **main facilities** including boilers, oil tanks and management/control building is about **44,000 m²**;
- The remaining site area can be estimated to be about **38,000 m²**.
- This area is enough for **10,000 m²** of solar thermal collector panels installation (land of **18,000 m²**), but for **35,000 m²** solar collectors area (land of **62,000 m²**) requires additional area outside power plant.





FINANCIAL ANALYSIS OF SOLAR THERMAL INSTALLATION IN CERAK POWER PLANT

- For the installation of the **10,000 m²** solar thermal collectors is necessary **2,5 mln. Eur CAPEX**. (without thermal storage, land and transmission line).
- **OPEX** makes **14,500 Eur** per year;
- **IRR** makes **8,5 %**;
- **Payback 10 years** (3% interest).





Thank You

Dr. Romanas Savickas

