District Heating and Cooling with District (hybrid) shallow geothermal Systems

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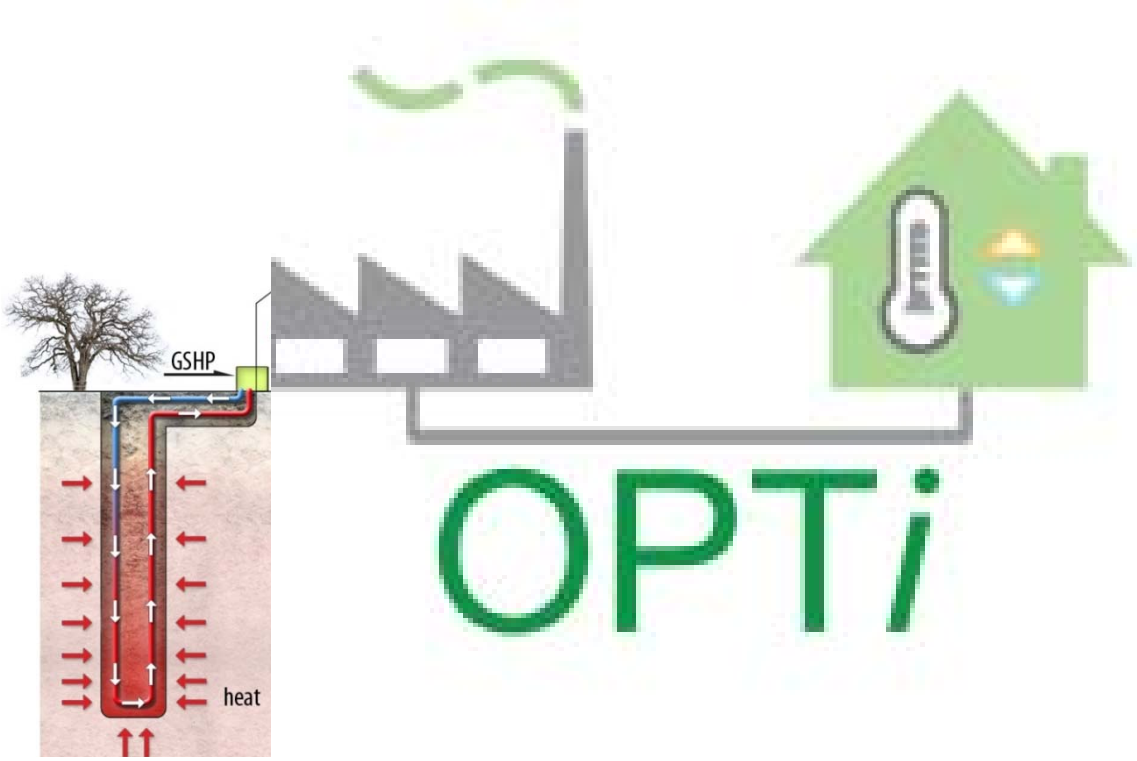
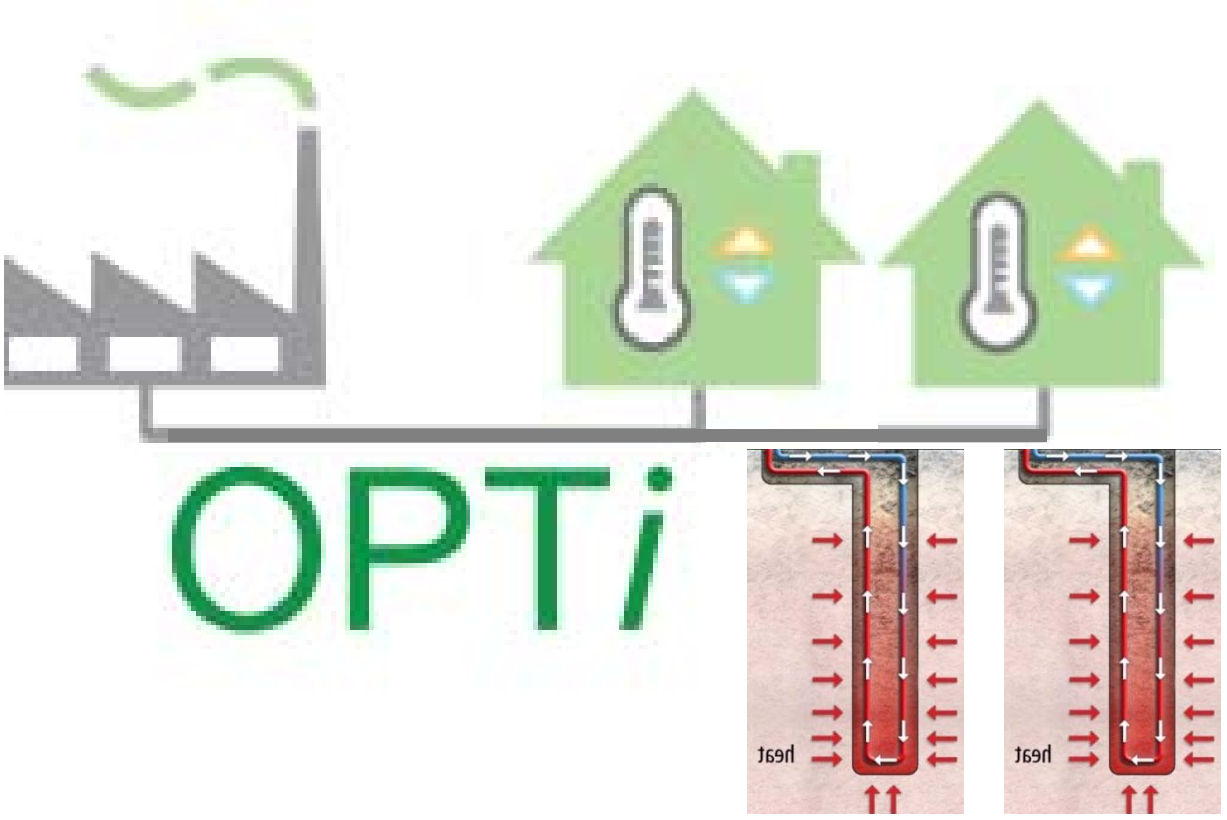
Geothermal – Thermal storage (to optimise)



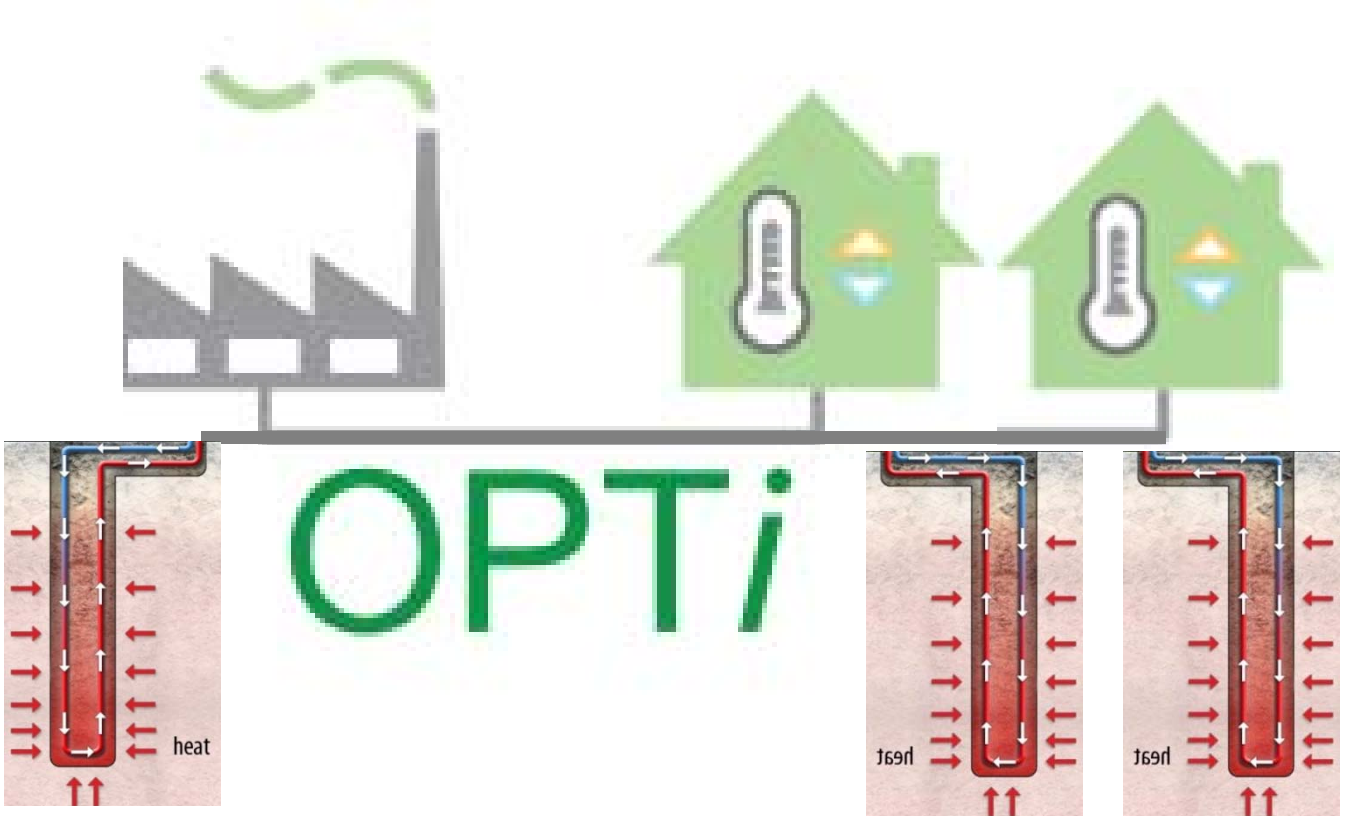
Thermal ‘battery’
(the ground!)

Geothermal – Thermal storage (to optimise)



Thermal ‘distributor’
(the ground!)

Geothermal – Thermal storage (to optimise)

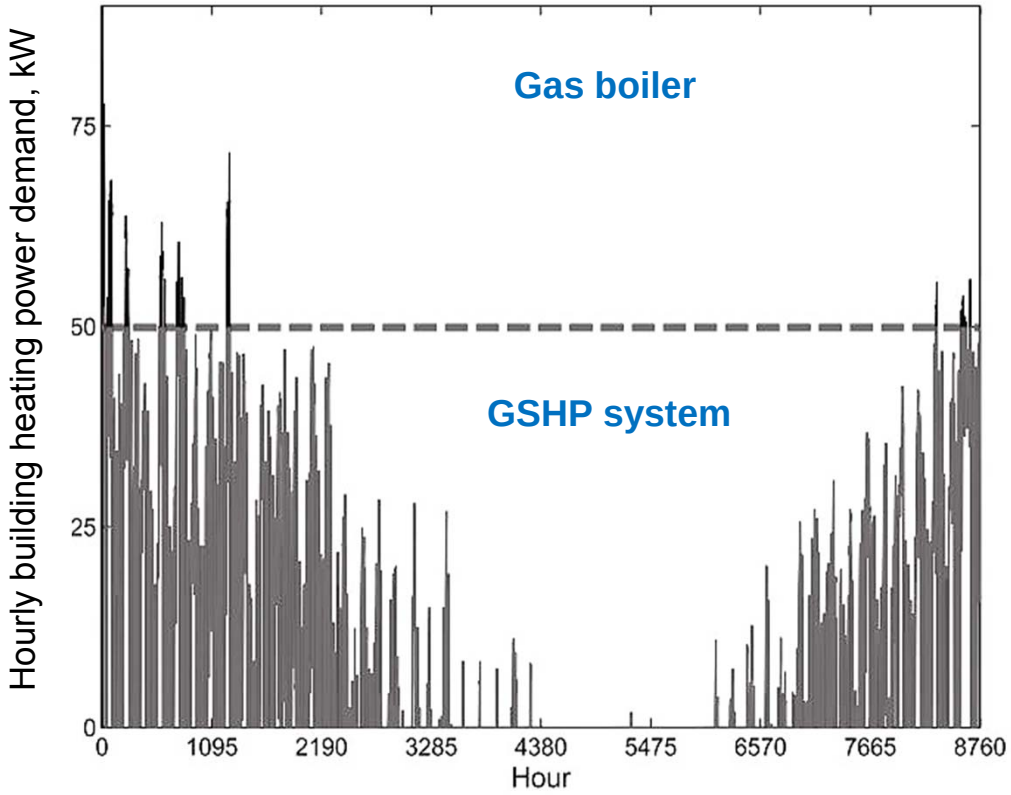


Thermal ‘battery’
(the ground!)

Thermal ‘distributor’
(the ground!)

District hybrid geothermal systems

Mikhaylova O., Soga K., Choudhary R., Johnston I. (2016), “Utilisation of Urban Open Spaces for Sustainable Heating and Cooling: a City-Scale Perspective”. Proceedings of ICEGT 2016. Kiel, Germany, 29-31 August 2016.



(Alavy et al. 2013)

Peak thermal power:

$HD_{max} = 83\ kW$

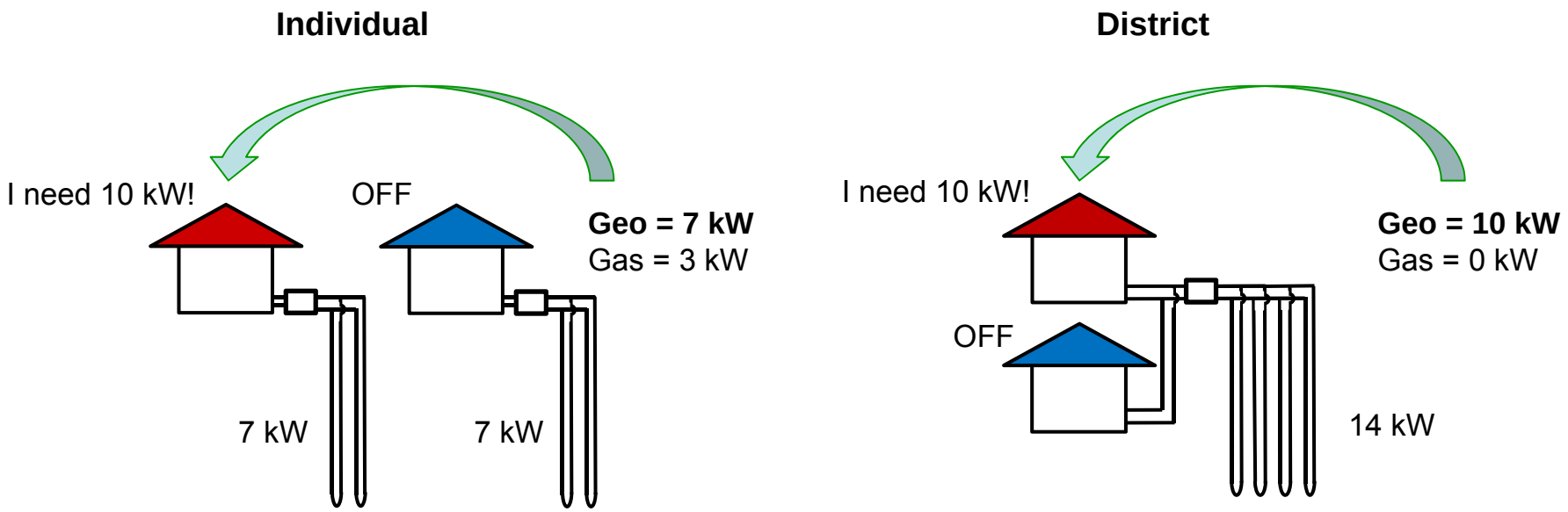
Shave factor: $\alpha = 0.6$

(greater α – more geothermal)

Maximum geothermal power:

- The capital cost is significantly reduced
- ~ 90% of energy still comes from the GSHP system

Individual and district hybrid geothermal systems



Individual vs. District HGSHP systems:

- Annual building heating demands are the same
- Installed capacity & capital costs are the same
- The district system can supply more geothermal energy

Individual vs district hybrid geothermal systems

Can district hybrid geothermal systems be more economical than individual hybrid geothermal systems of the same buildings?

Case study: Financial assumptions

Parameter	Value
Installation cost of 1 kW of GSHPs, ic_{GSHP}, £	240
Installation cost of 1 kW of gas boiler, ic_{boil}, £	25
Installation cost of 1 m of GHEs, ic_{GHE}, £	37.5
1 kWh from electricity, c_e, £	0.17
1 kWh from gas, c_g, £	0.05
COP of GSHPs, COP_{GSHP}	3.5
COP of gas boiler, COP_{boil}	0.95
Life time of HGSHP system T_{life}, years	20
Discount rate, DR	0.05
Government incentive rate per 1 kWh of geothermal heat, r_{RHI}, £	0.0884

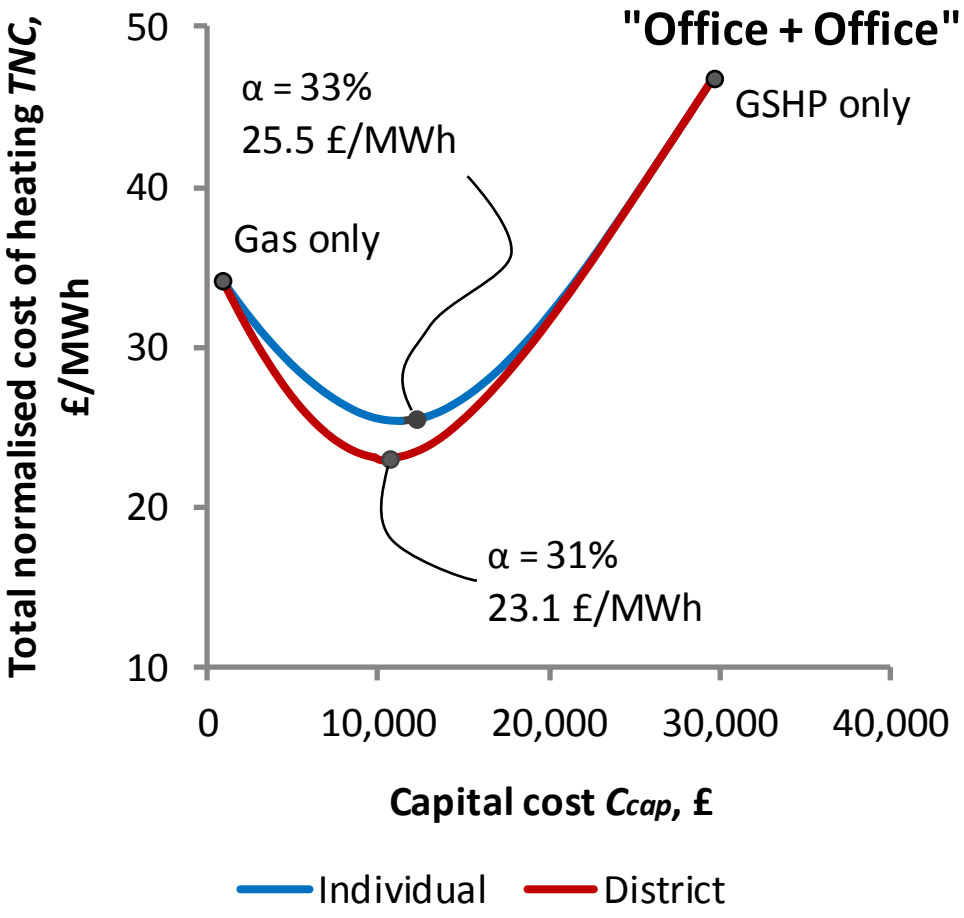
Case study: Analysis

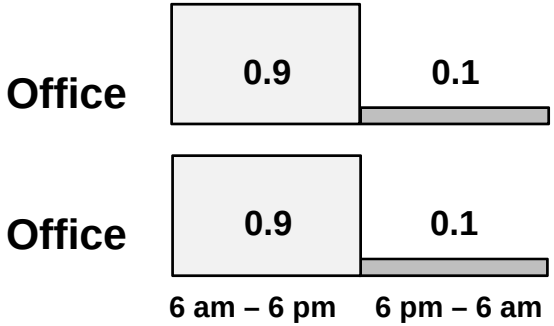
1. Individual and district HGSHP were sized for different shave factors α = (0, 1).

2. For each α, the annual energy provided by a GSHP and a gas boiler was calculated for individual and district HGSHP systems.

3. For each α, TNC and PBP were calculated for individual and district HGSHP systems.

Results: “Office + Office”





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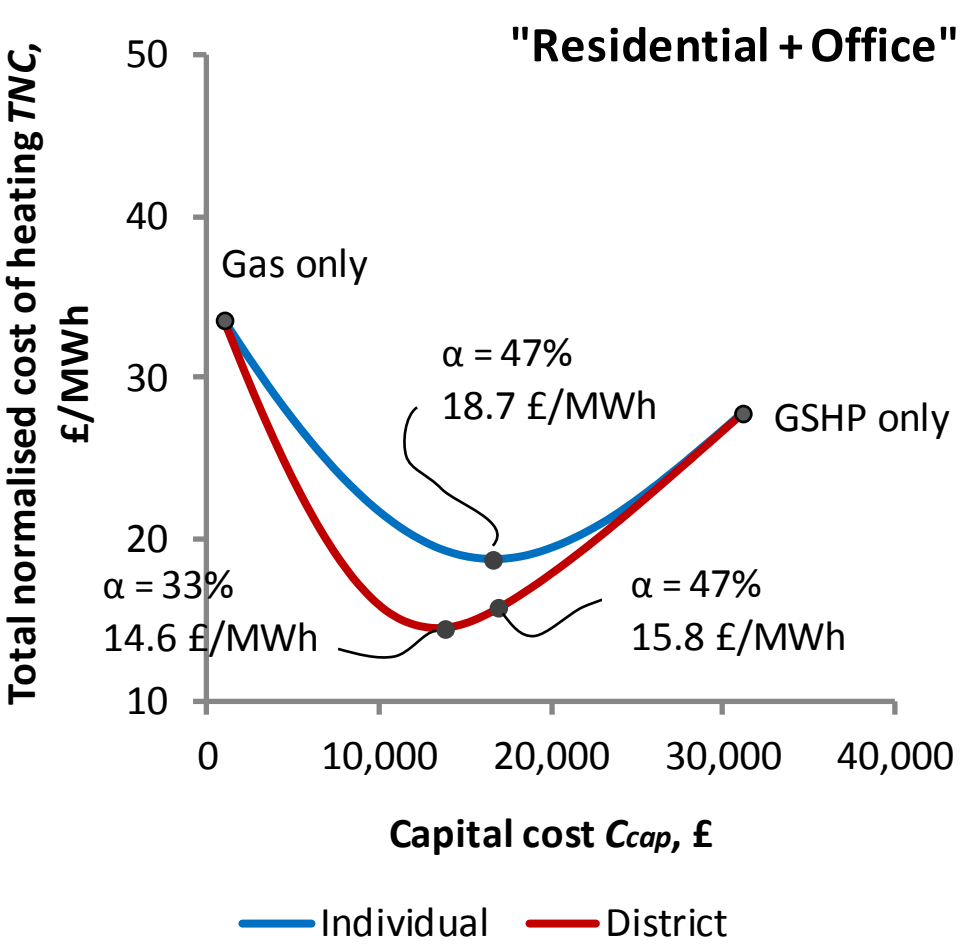
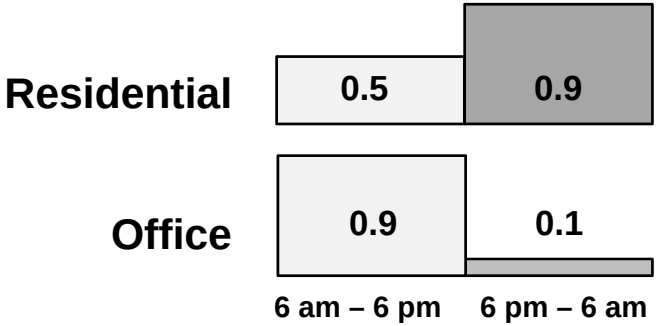
Results: "Residential + Office"





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Results: Payback periods