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SMRs technologies for district heating in the Czech Republic

NUCLEAR DAYS

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The bachelor´s thesis deals with analysing SMRs for heat production. It introduces several promising SMR concepts and analyses the heating system of the Czech Republic. The final part is devoted to comparing the given reactors for regional locations in the Czech Republic.

Small modular reactors

Small modular reactors are **nuclear reactors up to 300 MW(e)** with a safety zone radius of up to 300 meters. Modular means that the reactor is assembled in a compact box, the system is manufactured in series production and is only subsequently transported to the place of operation.

Overview of SMRs

Here is my overview of promising SMRs. The selection was based on power output and geographical diversification.

Reactor	MWt	MWe	Country of development	State of development
TEPLATOR	50	-	Czech Republic	Conceptual design
DHR400	400	-	China	2024 into operation
HAPPY200	200	-	China	2024 into operation
RUTA-70	70	-	Russia	Simulation
KLT-40 S	150	30	Russia	Commercial operation
SMART	365	107	Korea/SA	Design approved
BWRX-300	870	300	Japan	2027 into operation
ACP100	385	125	China	2026 into operation

Tab. 1: Overview of SMRs

The heating system of the Czech Republic

More than 1.5 million households are served by district heating. This fact is more common in the northern countries of Europe because they are experiencing a colder winter period than the Czech Republic.

The most used fuel in the energy mix of the Czech Republic is lignite (40%), followed by natural gas.

The biggest problem of the heating system is the price of emission allowances and the price of natural gas.

Of course, ecologization and decarbonisation are part of this issue, some coal sources have been converted to gas sources. A big topic is the reconstruction of steam heat distribution to reduce heat loss.

SMRs for heat production

This section contains a look at the **power regulation of nuclear sources**. Regulation of the nuclear source is undesirable from an economic point of view due to high investment costs. For my calculation, I take only reactors that operate without energy conversion. On the other hand, cogeneration production has the advantage of easy regulation during the year.

The first regulated production follows consumption during the heating season (based on comparative reports of the Energy Regulatory Office of the Czech Republic). Table 2 shows the regulation during the year and the heat supplied by the proposed reactors.

Reactor	Power (MWt)	Produced heat (TJ)				Total (TJ)
		2 months (100 %)	4 months (75 %)	2 months (50 %)	1 months (40 %)	
TEPLATOR	50	260	390	130	50	830
RUTA-70	70	360	550	180	70	1160
HAPPY200	200	1040	1560	520	210	3330
DHR400	400	2070	3110	1040	410	6630

Tab. 2: Demand-driven heat production

Second unregulated view assumes an average power load of 85% for 9 months (See Table 3). This approach is standard for nuclear sources.

Reactor	Power (MWt)	Produced heat (TJ)
		9 months (85 %)
TEPLATOR	50	990
RUTA-70	70	1390
HAPPY200	200	3970
DHR400	400	7930

Tab. 3: Unregulated heat production

Identification of suitable locations for a nuclear source

New location - evaluation of a new location using extensive **geological measurements**, there can be no occurrence of coal mining, which is a **big problem due to replacing outdated coal-fired power plants.**

The complex evaluation of a new location significantly exceeds the scope of my bachelor´s thesis.

=> Historically selected nuclear locations (**Tetov**, Opatovice nad Labem, **Blahutovice**)

=> Locations with a nuclear facility in operation (**Řež**, Temelín, Dukovany)

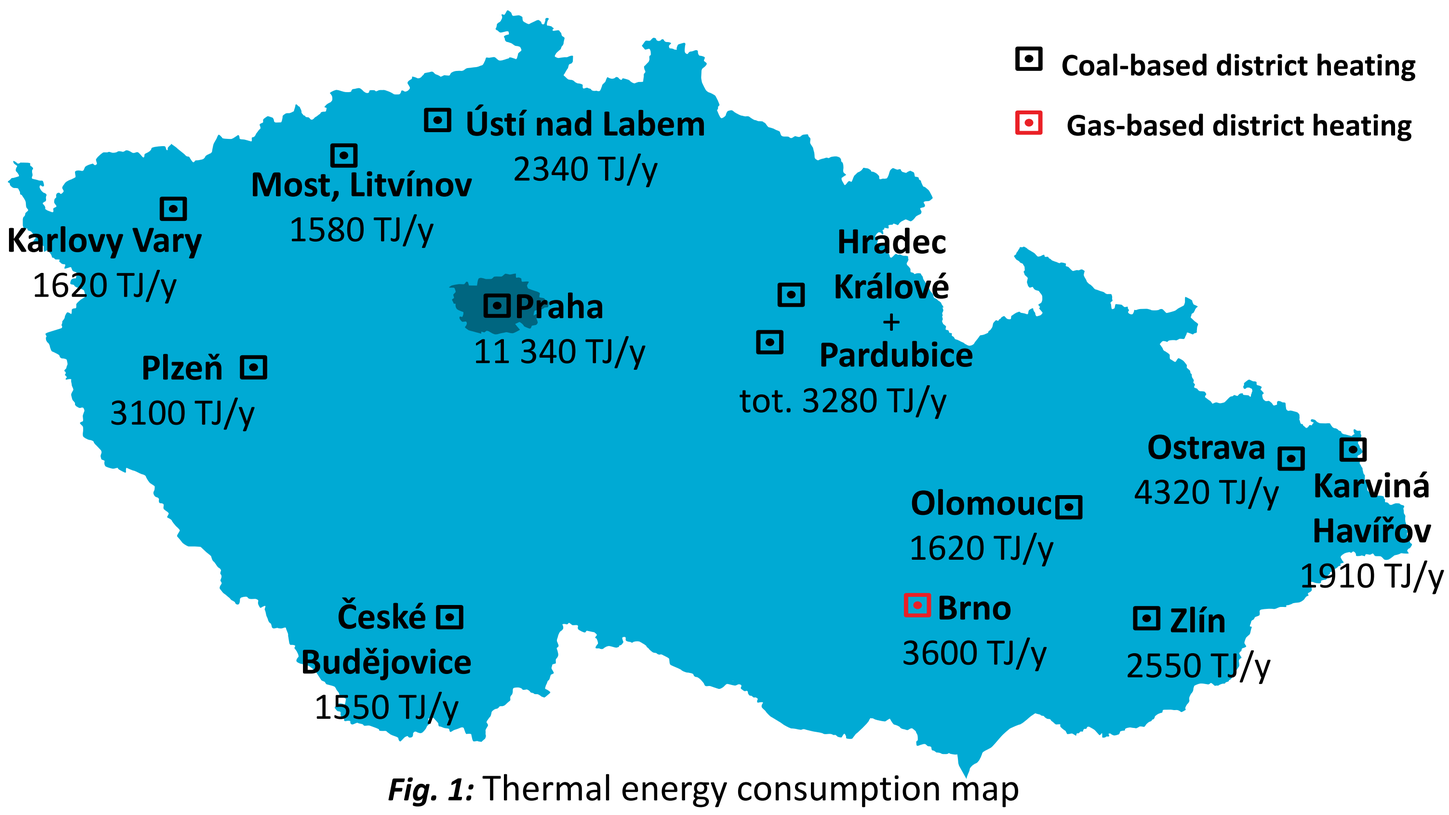

Fig. 1: Thermal energy consumption map

This evaluation is only based on the demand for supplied heat (See Table 3) and does not consider the requirements for nuclear source.

Based on performance diversification, we can choose any regional city and assign it to an individual reactor (See Fig. 1).

Results – proposed locations

Locations	Reactor type	Produced heat
Řež (Prague)	DHR400	7930 TJ/y
Blahutovice (Ostrava)	HAPPY200	3970 TJ/y
Tetov (Pardubice+Hr. Králové)	3x TEPLATOR	2970 TJ/y

Tab. 4: Proposed locations

Selection of all these variants is only based on the amount of produced heat, and supplemented with a gas source is required. **Considering power diversification, all reactors, especially with cogeneration, can be fitted to every regional city in the Czech Republic**.

Conclusion

Currently, proposed gas-fired power plants are a temporary solution -> SMRs may follow.

SMRs with cogeneration production can replace coal-fired power plants because of easier regulation and also represent zero-carbon heat production.

So far, no SMR has been approved and licensed in the Czech Republic.

These days, only one reactor, Akademik Lomonosov, is in commercial operation (See Table 1).