



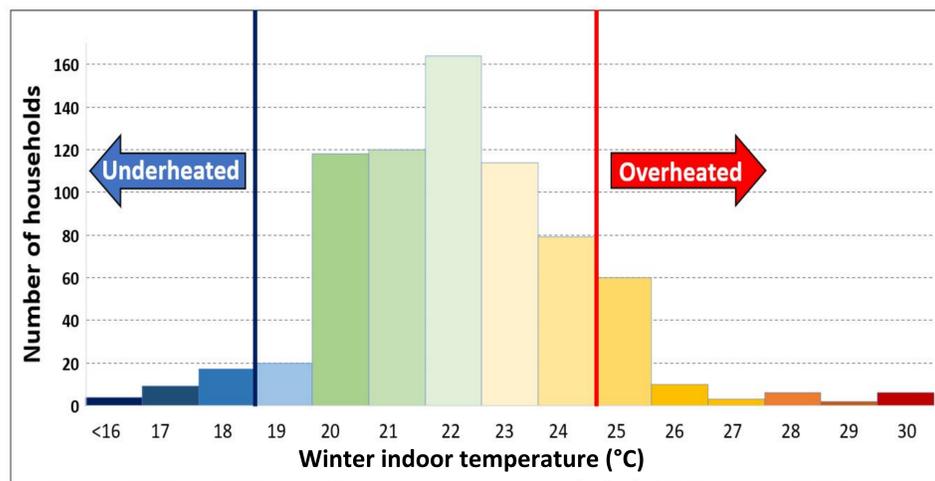
Firewood sustainability and energy poverty issues in a forested research area in Hungary

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Introduction: Field surveys and their results

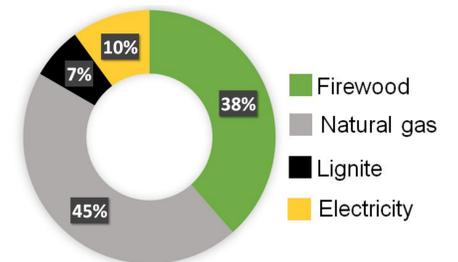
A custom database was created by implementing surveys that involved 15 settlements and 10% of their households (1354 units) in the Bükkalja region between 2016 and 2019. Its main focuses were on a) household energy consumption behaviour; b) mapping the current state of energy poverty; c) "actual energy billing data", including the type, quality, and quantity of utilised fuels; d) building energy characteristics and performance.



Indoor household temperature distribution in the heating season

Research area in figures:

- ❖ 564 km²
- ❖ 20 settlements in the Bükkalja region
- ❖ 36,000 inhabitants
- ❖ 13,000 households
- ❖ 52% forested - its 61% protected
- ❖ 29% arable land
- ❖ GDP/capita=65% of the nat. average



General residential heating energy mix

The results show that the average heated area is 90 m²/household and the mean heat utilisation is around 203 kWh/m² annually, placing an average building in the FF energy efficiency category. As a consequence of the substandard building stock condition, the average annual heating energy consumption is 18.3 MWh per household.

Based on the spreadsheet analysis and household fuel consumption, the results of the settlements' average **annual residential heat demand** ranged from 2,600 to 44,750 MWh (mainly depending on their population size).

The resulting usage of forestry biomass of the whole research area is 92,408 MWh/a.

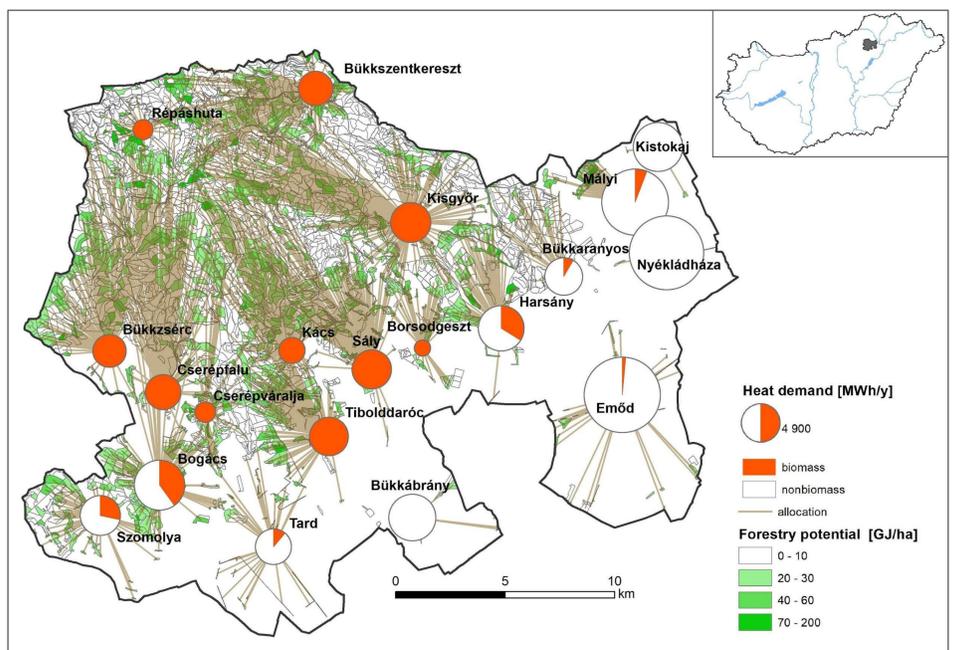
Sustainable firewood utilisation potential calculation: GIS analysis

The extent to which the local forests are able to cover the residential heat demand has been estimated. Two conditions were assumed: 15% moisture content of firewood and 85% efficiency of furnaces.

The **assessment of the forestry biomass potential** is based on the Hungarian National Forestry Database, which contains a wide range of data on every tree species for each subcompartment. The period from 2020 to 2050 was examined, and tree species under logging restrictions or with projected logging date after 2050 within the subcompartments were excluded.

Using ArcMap 10.2 "Location-allocation tool", each forestry subcompartment was allocated to that closest settlement in which heat demand was not covered by other, closer subcompartments already. A maximum transportation threshold of 20 km was applied, using the OpenStreetMap database. This way the potential heat demand coverage by local forests was calculated for each settlements.

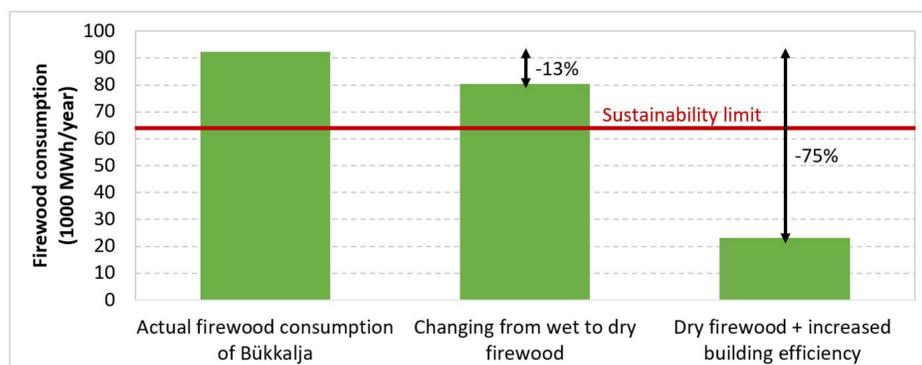
The resulting potential of forestry biomass of the whole research area is 60,893 MWh/a.



Sustainable firewood potential and transportation optimisation concept in the light of heat demand

Conclusion: Significant overconsumption of firewood

Considering the level of recent firewood utilisation (as local demand) and sustainable firewood potential (as supply), it can be stated that **the level of local overconsumption is ~52%**. Taking into account that the area's forest coverage is ~2.5 times higher than the country average, these forests need to satisfy not only local but regional needs. Therefore it possible that the overconsumption is even higher. It can be concluded that forests are under pressure and that high demand for firewood is a threat to biodiversity and undermines the climate benefit due to the loss of stored carbon.



Firewood consumption scenarios in comparison to the sustainability limit

Explanation of overconsumption:

- significant amount of uncontrolled firewood utilisation (due to energy poverty and its impacts as illegal logging - based on survey answers);
- low heating efficiency (obsolete heating equipment; missing insulation, substandard doors and windows);
- insufficient energy awareness.

Possible solutions:

- strict regulation to secure the sustainability of forests;
- increasing energy efficiency (with powerful and tailored campaign for insulation and better windows, including financial incentives);
- use of other local energy sources, as solar thermal and geothermal energy - also in new district heating systems;
- awareness-raising programs and one-stop-shop advisory tools, e.g. encouragement for dry firewood usage to decrease energy poverty.

Acknowledgements

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