Potential for biomass and energy production from semi-natural grasslands in Lääne County

LIFE Viva Grass project (LIFE 13 ENV/LT/000189)

Input to the Lääne county’s Entrepreneurship Development Plan

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1. Introduction

Semi-natural grasslands have been formed as a result of continuous, moderate or low intensity disturbance. If the disturbance regime ceases, these habitats evolve into bushland or forest, usually leading to a substantial loss of biodiversity. Although the area of semi-natural grasslands in Estonia has been progressively decreasing since the 1940s, there is still a considerable area and diversity of semi-natural grasslands. Only in Lääne County, 10 types of semi-natural grassland habitats are found (according the Habitats Directive Annex I classification).

Fig 1 compares the area of semi-natural grasslands and permanent grasslands (not sown or fertilized for at least 5 years) in all the counties in Estonia. There is no single database that contains all data on semi-natural grasslands in Estonia. Therefore, in order to generate an estimate as close to reality as possible, it is necessary to combine several databases. In this particular case, the information about semi-natural grasslands (location and extent) has been compiled from two databases:

KR_PLK: This map layer layer is contained within the Estonian Nature Information System database. KR_PLK comprise the location and extent of all semi-natural grassland sites eligible for agri-environmental payments within the Pillar II subsidies system of the Common Agricultural Policy.

PKY: Estonian Seminatural Community Conservation Association has compiled this map layer during several years.

The area and location of permanent grasslands has been calculated from the PRIA database for reference year 2015.

2. Potential for biomass and energy production from semi-natural grasslands in Lääne County

As shown in Figure 1, Lääne and Saare Counties hold the highest area of semi-natural grasslands (approximately 20 300 and 24 100 ha respectively). This is a vast difference when compared to the area of semi-natural grassland in other counties.

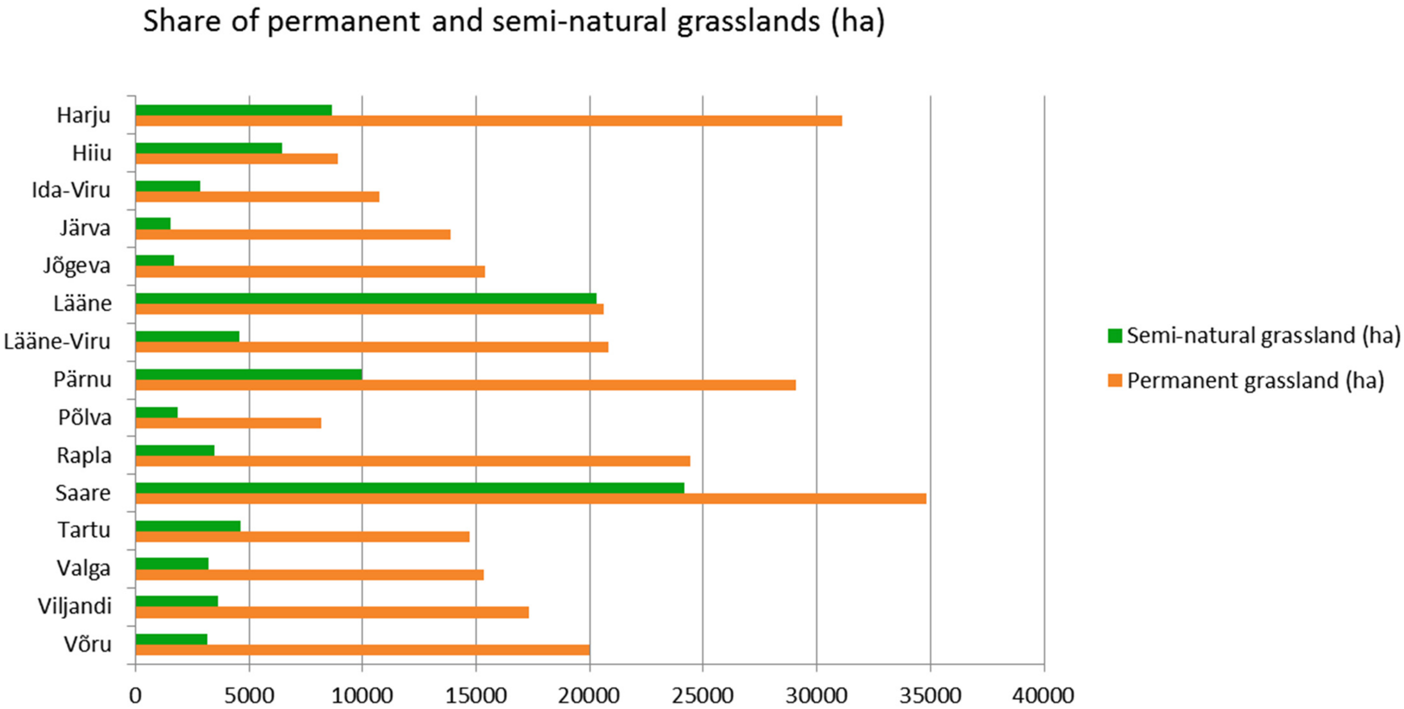

Fig 1 Area of permanent and semi-natural grassland in all Estonian Counties

In order to better understand the location and composition of semi-natural grasslands in Lääne County, Figure 2 contains a map and a graph showing the proportion of each semi-natural grassland type occurring in Lääne. The dominant grasslands types in the County are alluvial meadows (6450) 6266 ha, coastal meadows (1630) 5923 ha, alvars (6280) 1869 ha and wooded meadows (6530) 1694 ha. Whereas alvars and wooded meadows are evenly spread within the region, coastal meadows are mainly located in Haapsalu and Matsalu bays and alluvial meadows in Matsalu bay.

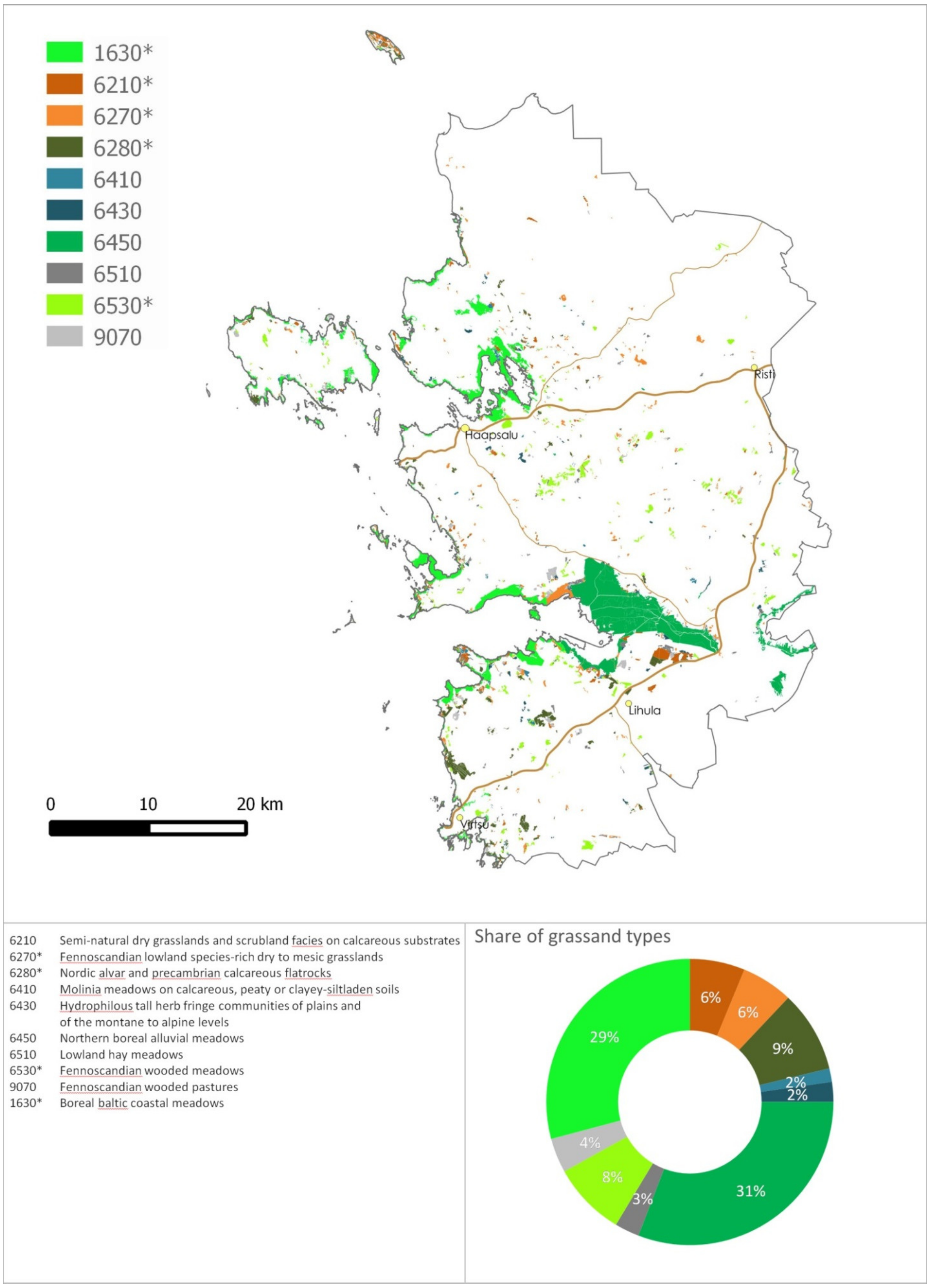

Figure 2. Distribution of semi-natural grasslands in Lääne. The classification system used here follows the Habitats Directive annex I habitat codes

Several studies have been published containing information about the productivity of semi-natural grasslands in Estonia. Table 1 contains the potential biomass production of the main grassland types occurring in Lääne County. However, several important considerations must be taken into account when dealing with these data. Firstly, the productivity data refers to potential rather than actual productivity. Potential biomass production is the biomass production that would be achieved in a certain grassland type under its optimal management regime. Secondly, grassland productivity varies greatly both geographically and in time, depending on each year's weather conditions. Furthermore, some grassland types are more variable in terms of productivity than others. Specifically alvars, which due to the thinness of the soil and the limestone bedrock show high yearly variation in terms of productivity. Therefore, the data contained in Table 1 must be regarded as estimates with guidance purposes rather than precise calculations.

Grassland type	Area (ha)	Estimated biomass production potential (kg/ha yr ±SD)*	Total biomass production potential in Lääne (t/yr)	Energetic value (kJ/g)*[2]
6210	1261	-		
6270*	1181	-		
6280*	**1869**	**1328** ±119	**2482**	
6410	311	-		
6430	455	-		
6450	**6266**	**7433** ±1716	**46575**	18.4
6510	564	-		
6530*	**1694**	**1986** ±300	**3364**	18.1
9070	793	-		
1630*	**5923**	**3050** ±360	**18065**	

Table 1. Area and potential biomass production of semi-natural grasslands in Lääne County

*The estimates of potential biomass production have been compiled from several publications and studies carried out in Estonia. The full list is located in the references section.

*[2] Heinsoo et al (2010) estimated the energetic value for alluvial meadows and wooded pastures

Figure 2 shows the distance to main roads in Lääne County. Distance to roads should be an important criterion to take into account when planning the location of a plant for grassland processing, pelleting, burning or biogas/biofuel conversion. In Fig 2, those areas shown in yellow/orange/red are more "isolated" in terms of distance to main roads and therefore, grasslands located in those patches are more inaccessible.

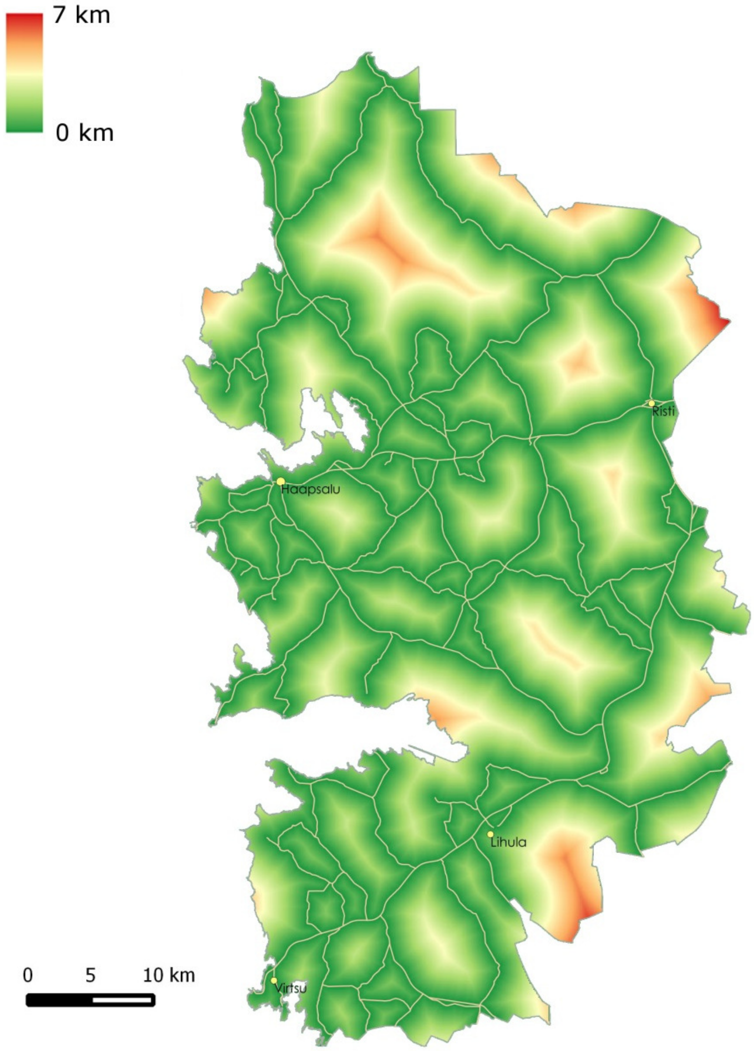

Figure 2. Distance to main roads in Lääne County

3. Guidlines for cost-benefin analysis

The two main questions a cost-benefit analysis should answer are following:

- Do benefits outweight the costs and by how much?
- Comparing project options based on the total expected costs and the total expected benefits

➔ Benefits and costs expressed in monetary terms

Common process:

List alternative projects/programs.

List stakeholders.

Select measurement(s) and measure all cost/benefit elements.

Predict outcome of cost and benefits over relevant time period.

Convert all costs and benefits into a common currency.

Apply discount rate.

Calculate net present value of project options.

Perform sensitivity analysis.

Adopt recommended choice.

EU GUIDELINES**:**

Should include:

- Opportunity cost
- Long-term perspective (10 to 30 yr)
  – set a proper time horizon
  – forecast future costs and benefits (looking forward)
  – adopt appropriate discount rates to calculate the present value of future costs and benefits
  – take into account uncertainty by assessing the project's risks

- Calculation of economic performance indicators expressed in monetary terms
- Microeconomic approach (avoid wider regional impact, leads to double-counting of benefits)
- Incremental approach: Compare the project with a counterfactual base scenario (what would happen without the project)

4. Guidelines for biomass for energy CBA

The present document is conceived as a set of guidelines and recommendations for a Cost-Benefit Analysis (CBA) of a grass biomass-based district heating plant project. Each project has particularities determined by the geographical location, LULC and socio-demographic characteristics of the study area. Moreover, the range of technological approaches to produce energy from semi-natural grasslands is broad and therefore each project requires specific operational steps. The CBA guidelines provided here refer to an Integrated Generation of Solid Fuel and Biogas from Biomass (IFBB) for district heating (**Bühle et al., 2012**). In the present CBA example, only grass from semi-natural grasslands is considered as biomass feedstock, given the particularities of Lääne County and the exceptional extension of semi-natural grasslands in the area.

The European Commission Guide to Cost-Benefit Analysis of Investment Projects (Sartori et al., 2014) contains a number of key aspects and project appraisal steps that should be included in a CBA (Fig. 1). The present report provides a deeper insight in points 3 and 4 (Fig. 1). Beyond these points, a CBA should also include a long-term perspective analysis (10 to 30 years) in order to forecast future costs and benefits, as well as adopt appropriate discount rates to calculate the present value of future costs and benefits. Within the long-term perspective, the level of uncertainty should be taken into account by assessing the project's risks. Moreover, the European Commission highlights the benefits of undertaking an incremental approach, in which the project scenario is compared with a counterfactual base scenario (costs and benefits when the particular project under consideration would not be implemented).

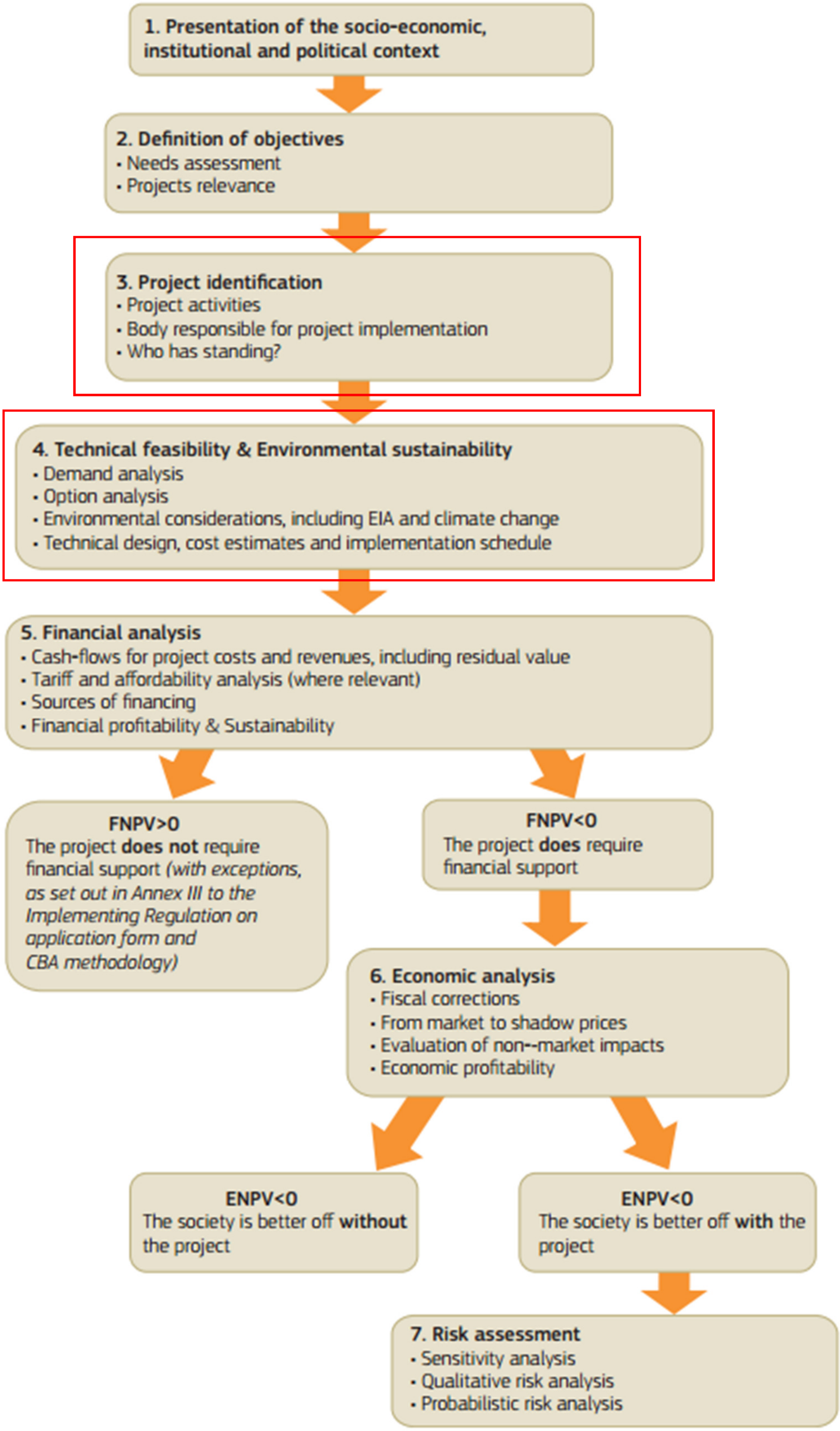

Fig. 1: Sartori et al (2014) identified key aspects and project appraisal steps to be included in a CBA

4.1. Costs analysis

In the example presented here (Fig. 2), the project steps and components are described for a district heating facility following an Integrated Generation of Solid Fuel and Biogas from Biomass (IFBB), as described in Bühle et al (2012). However, regardless of each project's particular implementation steps and bio-energy production technologies used, the Life Prograss Project (LIFE07 ENV/D/000222) identified a number of factors that influence the economic profitability of the project:

- Pellet / briquette price.
- Location close to a biogas plant generating low-cost waste heat.
- Close distances between plant and grassland sites.
- Geographic proximity to an existing biomass pellet or briquette production facility (pellet blending) or to a biomass furnace (eg heating plant).
- Increase of prices of solid fuels.
- Investment costs.
- Labour costs.
- Maintenance and repair.
- Costs of processing energy.
- Costs and composition of grassland substrates.
- Grassland harvest yields.
- Transport costs.
- Public funding and subsidies (EU area payments, environmental measures applying to agriculture).
- Amount and interests for external capital.

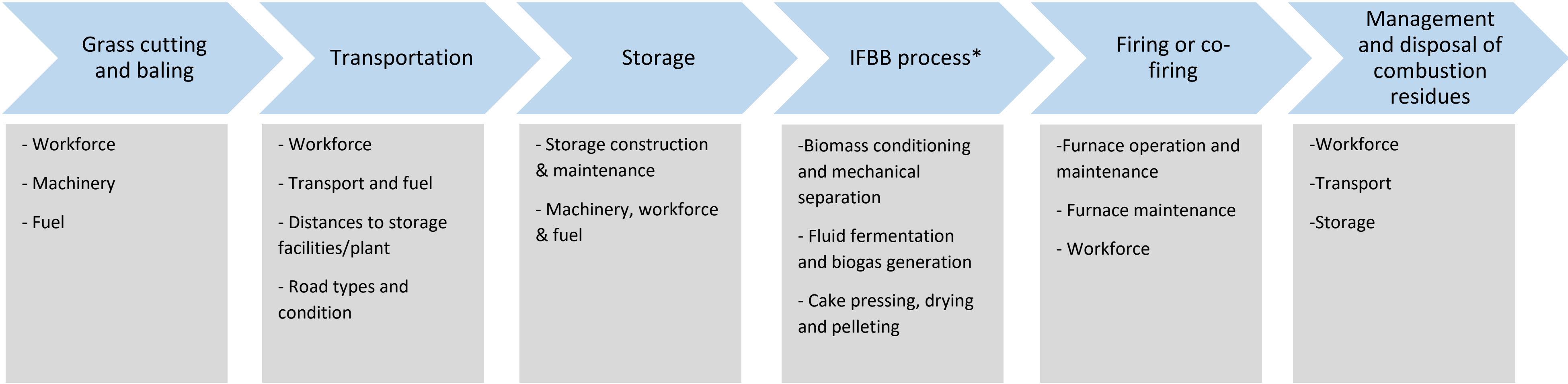

Fig. 2: Operational steps and associated costs that should be taken into account in the CBA of an IFBB grass-powered district heating plant

4.2. Demand analysis

Within the *Technical feasibility* (Fig. 1) assessment of the project, the demand for the specific project's outputs should be analyzed. Eliciting both **current** and **future** demand shows the project feasibility and long term sustainability, as well as helps quantify a fraction of the project's beneficiaries.

In the particular case of the usage of semi-natural grasslands biomass for heating, there are a number of indicators that will help assess the demand for current and future heating power:

- Current heat/energy consumption
- Density of buildings
- Density of population
- Future density of population (prognosis models to elicit future energy demands)

Fig 3. exemplifies how current and future density of population can be used as means of detecting hot and coldspots for energy consumption.

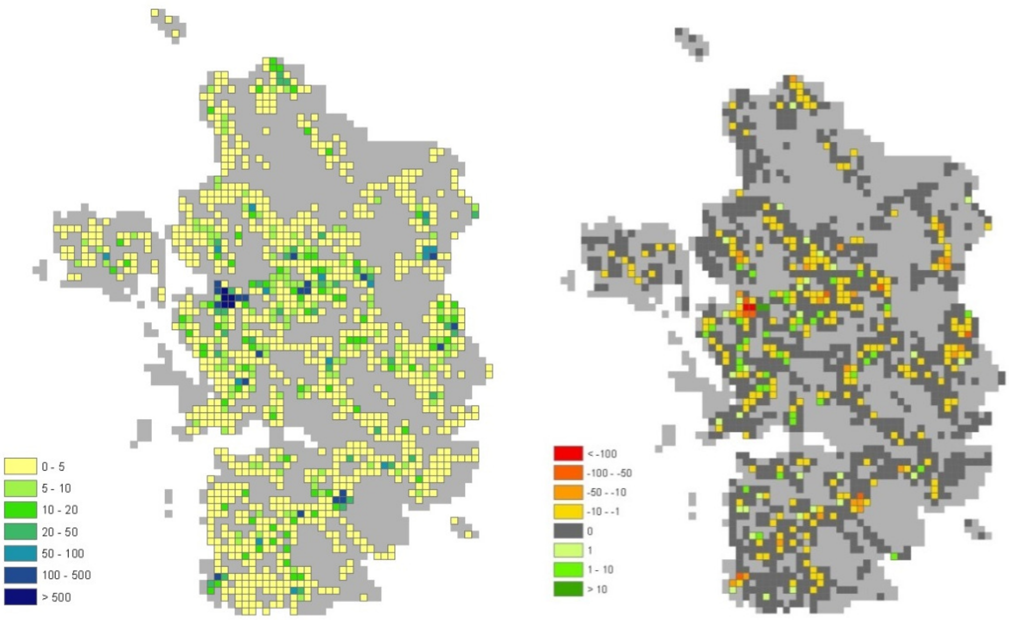

Fig. 3: Current population density and 15 years population density forecast in Lääne County (based on Statistics Estonia datasets)

4.3. Benefits and options analysis

When accounting for the benefits, financial profitability and sustainability of the project, there are several aspects to be considered in the analysis. These aspects should also help in evaluating alternative project options:

- Market values
  - Direct economic benefits (i.e. direct benefits to the farm economy)
  - Indirect economic benefits (i.e. subsidies)

- Evaluation of non-market impacts: Stimulating the extensive management of semi-natural grasslands by using grass for pelleting and subsequent heat generation leads to maintianed or improved levels of biodiversity. When considering grass from semi-natural grasslands vs other energy options (specifically, dedicated energy crops), other impacts shall be considered, namely:
  - GHG emissions
  - Impacts on soil erosion
  - Decreased/increased nutrient leaching
  - Changes in soil fertility

- Replaced function: Benefits and costs of the replacement of the same function (heating or electricity generation) with fossil based technologies.

- Displaced function: Benefits and costs of a hypothetical displacement of food, energy crop systems or forage supply for animal husbandry. This will rarely be the case for semi-natural grasslands.

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