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BIOMASS POTENTIAL: STATIC AND DYNAMIC, LONG TERM AND SHORT TERM

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Content

1. Methodology of determination of biomass potential based on soil and climate conditions on land plots
2. Static and dynamic / standard and additional biomass potentials
3. Case studies for selected regions in the Czech Republic
4. Economic dimension of static / dynamic / standard and additional potential
5. References

Methodology of biomass potential

Results based on:

- ❑ long term field research – experimental plantations of energy crops
- ❑ long term data collection – conventional crop yields and biomass from forestry
- ❑ research projects aimed at biomass potential identification, economic aspects of energy crop, biomass as the local source, biomass in crisis, etc.
  - ➢ Ministry of Environment
  - ➢ Ministry of Interior
  - ➢ Technological Agency of the Czech Republic

Biomass availability

- ***Do we have realistic plans for biomass future ?***
- ***How we can include individual constraints into biomass potential determination ?***
- ***What is the time dynamics of biomass potential ? And its regional distribution?***
- ***Can we mobilize biomass potential when needed ?***
- ***What is the economic dimension of biomass potential***

Biomass potentials – different approaches

Static / standard biomass potential

- **Theoretical** – land available, climate, access to water etc.
- **Technical or geographical**: other area specific constraints are included – biodiversity protection, natural parks, preference of conventional crop, recreation, rotation of crop, etc.
- **Economic** – only such part of biomass potential which is competitive with conventional fuels under the given standard market conditions
- **Realistic** – also includes technological limitations on side of consumption – e.g. grass and biogas stations, burning of straw (creation of “glass” in boiler, etc.)

Static and dynamic biomass potentials

Static (standard) biomass potential

- Biomass potential sustainable in longer run - i.e. all legal, environmental and other constraints („food policy“, material utilization, etc.) for biomass production are taken into account
- It reflects current status – e.g. land availability for conventional and energy crop, structure of conventional production, % allocation for energy crop, current biomass yields, etc.

Dynamic biomass potential

- additional potential - short term “boosting” of biomass potential
- changes of biomass potential in longer run (10-30 years)

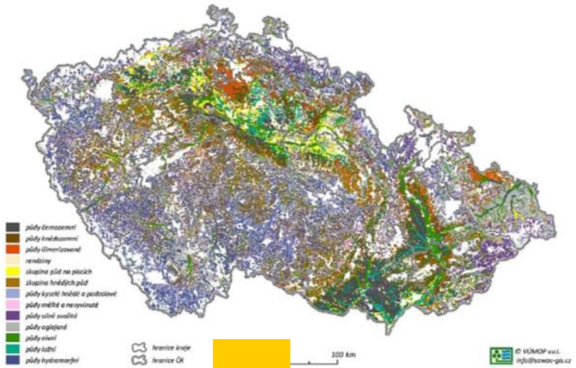
Biomass potentials – bottom up approach

Methodological approach based on long-term experiments and data collection (app. 2 decades)

- Biomass yields are the function of soil and climate conditions on site – at given land plot (as the expected yields)
- Biomass potential in given area is the sum of contribution from individual land plots - bottom up approach
- Land valuation is used as the key parameter to determine expected biomass yields
- Constraints (e.g. for energy crop) included
- GIS model

VSEU – soil and climate conditions on site

Soil types



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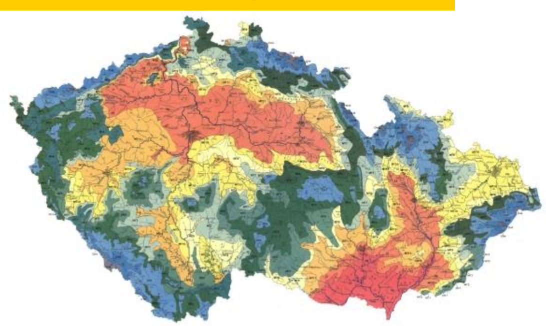
Climate regions



Land valuation

VSEU

XYYWZ

MSCU

X:10 dif. climate regions

(similar conditions for crop growth)

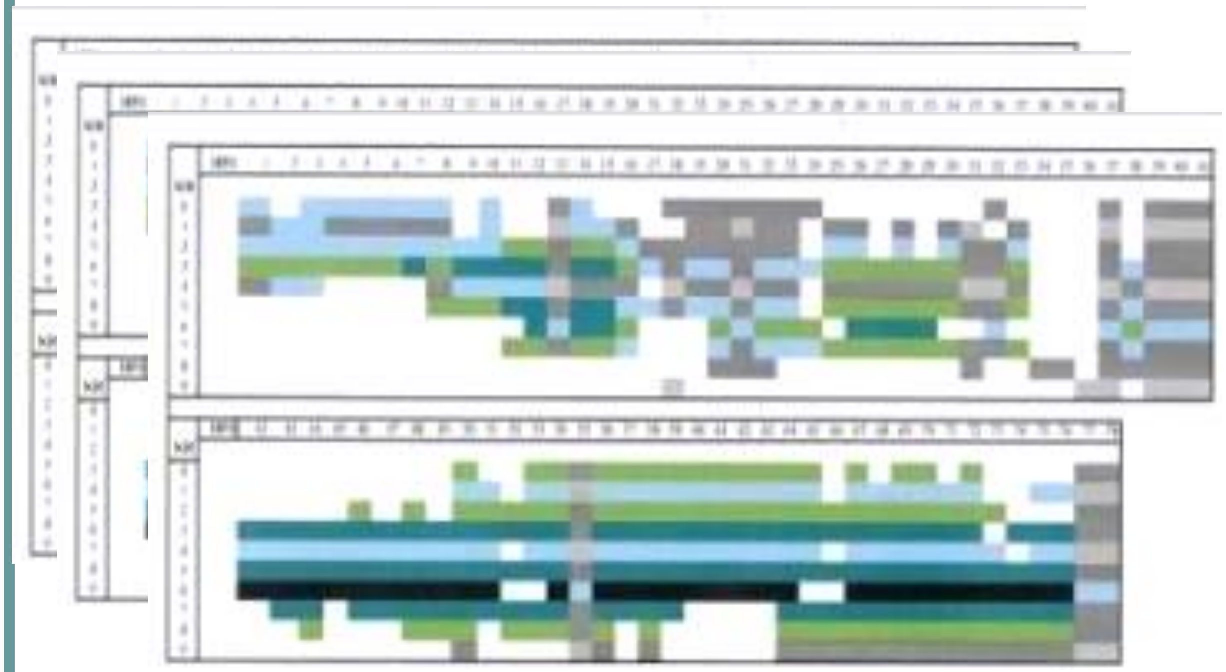
YY: main soil units

(soil type, subtype, soil matrix and the degree of hydromorphism)

W: comb. of slope and exposure

Z: depth of the soil profile and its skeleton

Typology of agricultural sites



Empirical data

Experimental plantations

Expert estimates

MSCU: Up to 550 valid combinations (climate + soil)

Identification of typical biomass yields for given conditions

Yield curves (5-7 for each conventional type of energy crop)

Examples of yield categories

Yield cat.	**SRC** [t (DM).ha^{-1}]	**Miscanthus** [t (DM).ha^{-1}]	**Schavnat** [t (DM).ha^{-1}]	**Reed canary grass** [t (suš).ha^{-1}]
K1	< 5,01	<5,01	<2,51	<3,76
K2	5,01–7,00	5,01–9,00	2,51–5,00	3,76–5,25
K3	7,01–9,00	9,01–13,0	5,01–7,50	5,26–6,75
K4	9,0 1–11,00	>13,1	7,51–10,00	6,76–8,25
K5	11,01–13,00	-	>10,00	>8,25
K6	>13,00	-	-	-

Typology of forests

- Yields of biomass are based (as in case of agricultural land) on primary information about the soil conditions and forest type (set of forest types):

  XYZ

  X … forest vegetation levels 0-9 (e.g. 1 means oak forest up to 350 meters above the sea level)

  Y … forest soil types A-Z

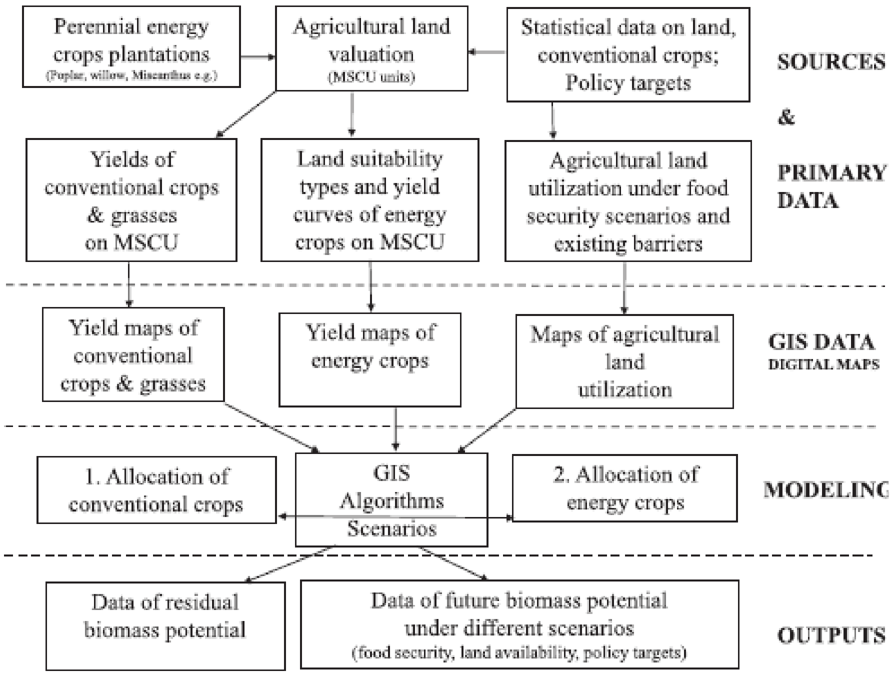
  Z … index of forest type in given forest area

- Up to 170 valid combinations of forest vegetation levels and forest soil types
- Age of forest (forest production plans)

Biomass potentials – structure of the model

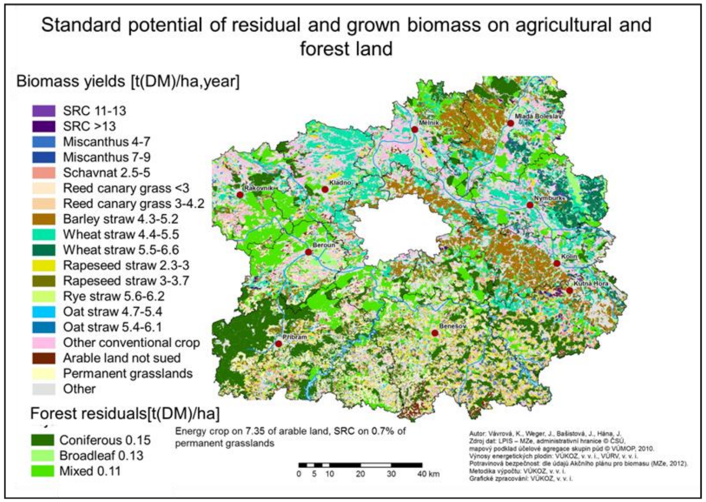
Model parameters

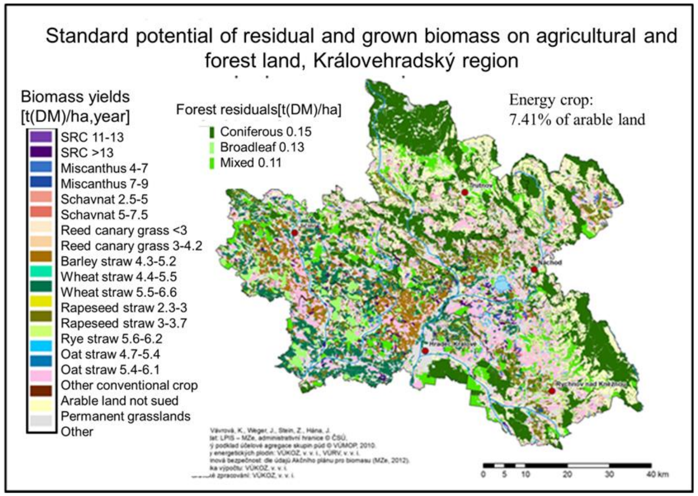
- ❑ region selection (country, official regions, any region)
- ❑ land allocation for energy crop (relative)
- ❑ structure of conventional crop, order of land allocation
- ❑ environmental, legal and market limitations
- ❑ layers with transportation distances and price modeling



Example – static potential and its distribution

Residual and grown biomass on agricultural and forest land – Central Bohemian and Kralovehradsky region





- ❑ Criteria for crop allocation: basic alternative - preference of conventional crop, order of crop allocation to land plots according to the requirement for land quality
- ❑ Non linear function of biomass potential on land allocated for energy crop
- ❑ Significant reduction of previous expectations – both on agr. land and forest land

Additional potential - short term boosting of biomass potential

Sources of additional biomass potential

- ❑ part of straw which is ploughed into soil to keep the soil quality (changes of straw to grain coefficient),
- ❑ part of straw which is used for farm animals,
- ❑ shortening of rotation cycle o SRC plantations,
- ❑ increase of dendromass used for energy purposes (e.g. shortening of forest production cycle or change of categorization of harvested wood).

Note: “additional” means possibility of immediate reaction and strongly depend on the season, related with the growth cycle

Results of modeling – additional potential

Case study of biomass potential for the two region of the Czech Republic (4% land allocated for energy crop)

Region	**South Moravian**	**Highlands**
Area [km^2]	7195	6796
Agr. land share [-]	0,6	0,6
of which arable l. [-]	0,83	0,77
Standard pot. [TJ]	13 338	8 356
Boosting of pot.		
- total [-]	1,23	1,19
- agr. land [-]	**1,15**	**1,16**
- forestry [-]	2,95	1,42

Time dynamics of biomass potential

Key parameters:

- ❑ Changes in land availability (e.g. new areas with environmental protection)
- ❑ Changes in the structure of conventional crop
  - ► *Agriculture policy*
- ❑ Development of land allocation for energy crop
  - ► *Biomass Action Plan (link to NREAP)*
- ❑ Changes in biomass yields thanks to the improved seed and planting material and improved agrotechnologies

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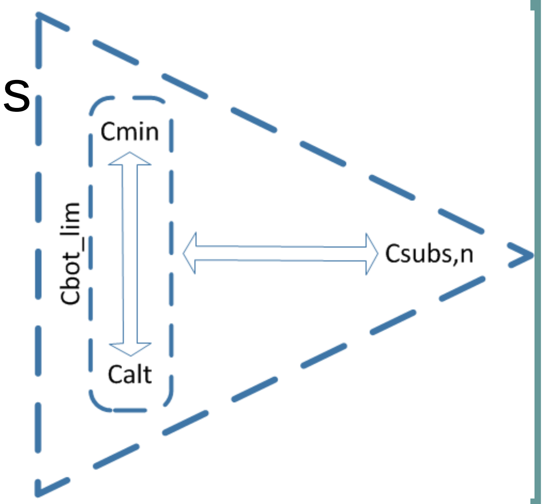
- ❑ Impact of climate changes – necessary changes in typology of agriculture sites (new empirical data needed)

Agriculture land is the scarce/limited resource !

Biomass potential and real contribution to PES balance:

- ❑ Agrotechnologies
- ❑ Biomass yields – soil and climate conditions
- ❑ Land used for food production
- ❑ **<u>Economic competitiveness</u>**



Biomass price and competitiveness:

❑ Biomass price modeling – economic effectiveness of the project

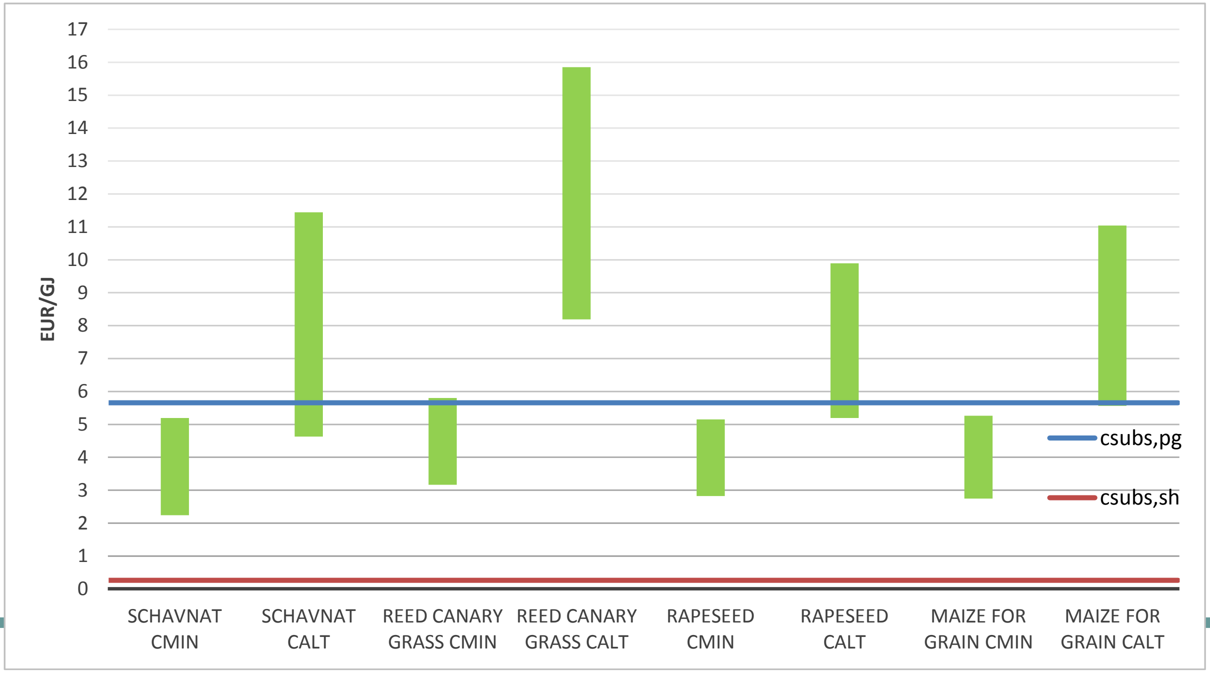
❑ Competition with conventional agri production – farmers will require the same economic benefit from land utilization

❑ Substitution of fossil fuels – customers will accept only such price of biomass which ensure the same cost from fuel utilization

Competitiveness significantly limits biomass potential

Current situation:

- ❑ Competition for land and high profitability of conventional production pushes up price of grown biomass
- ❑ Cost of fuel substitutes (coal and natural gas) reduce max acceptable biomass price for consumers



Conclusion

- Estimation of biomass potential based on soil and climate conditions on individual land plots makes estimates more realistic
- Methodology enables:
  - Potential modeling on different levels and based on different scenarios (e.g. priority of land allocation, different constraints for energy crop, etc.)
  - **Inclusion of long term and short term time dynamics**
  - Inclusion of biomass price to reflect biomass competitiveness (and to reduce biomass potential)
- **Additional biomass** potential can increase standard potential typically between 10 and 40%
- High profitability of conventional agriculture production pushes up minimum acceptable price by farmers

Details available at:

- VÁVROVÁ, K., KNÁPEK, J., a WEGER, J. Short-term boosting of biomass energy sources – Determination of biomass potential for prevention of regional crisis situations. **Renewable and Sustainable Energy Reviews**. **2017**, 67s. 426-436. ISSN 1364-0321. DOI: https://doi.org/10.1016/j.rser.2016.09.015
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Thank you for your attention !

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