Discussion Seminar

Current Energy Issues in Central Europe

Biomass potential and competitiveness as the energy source - case example of the Czech Republic

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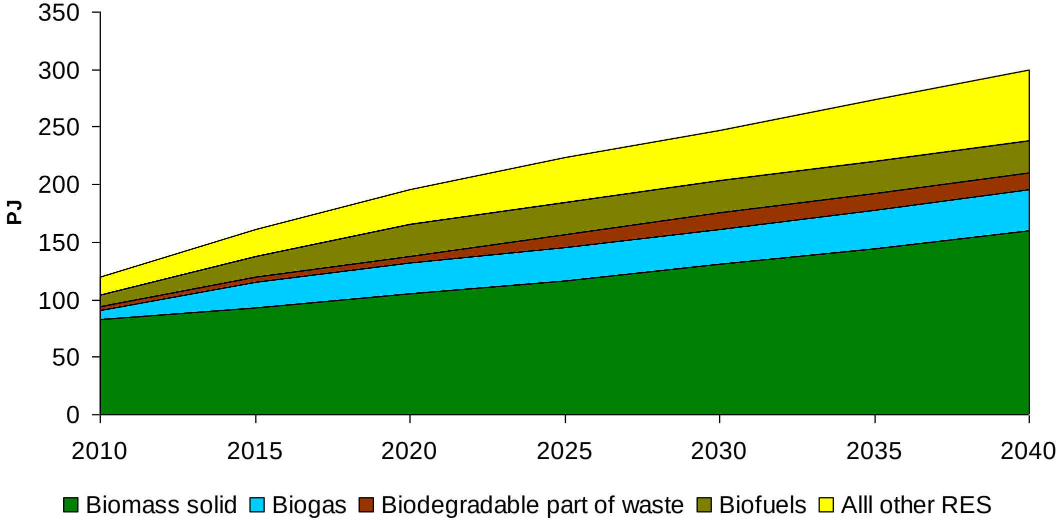
Present state – biomass plays the decisive role in RES strategies

EU28 (2012)

- Total production of renewable energy reached 7423 PJ
- 22,3 % of total primary energy sources
- Biomass contribution: app. by 65,5% to total sum of RES



Biomass plays even more important role in the Czech Republic

Biomass availability in long run

- ***Do we have realistic plans for biomass future ?***
- ***How we can include individual constraints for biomass potential determination ?***
- ***What is the structure of biomass potential and its regional distribution ?***
- ***Can we mobilize biomass potential when needed ?***
- ***Economic competitiveness of intentionally planted biomass on agriculture land – do we have realistic expectations ?***

Methodology of biomass potential determination

Specification of biomass potential

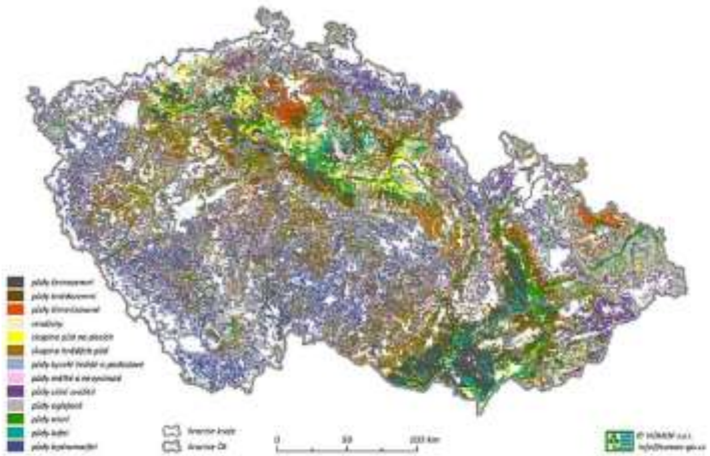
- high variability of current biomass potential estimates
- necessary to check where are the boundaries of potential
  - yields as the function of soil and climate conditions

Determination of biomass potential as the function of relevant parameters

- region selection (country, official regions, any region)
- land allocation for energy crop (relative)
- priorities for land utilization, available agrotechnologies
- environmental, legal and market limitations

VSEU – soil and climate conditions on site

Soil types



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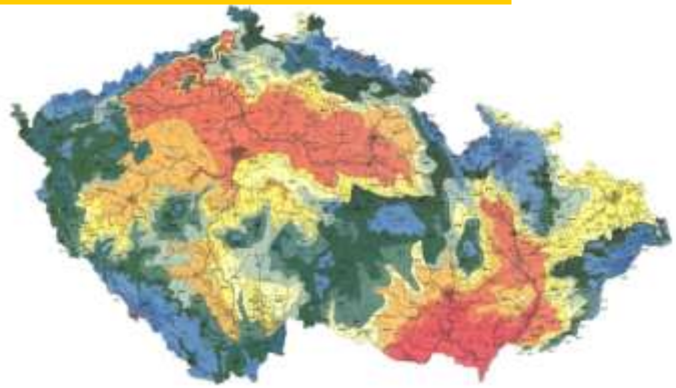
Climate regions



Bottom up approach, land plots conditions

VSEU

XYYWZ

MSCU

X:10 dif. climate regions

(similar conditions for growth of agr. crop)

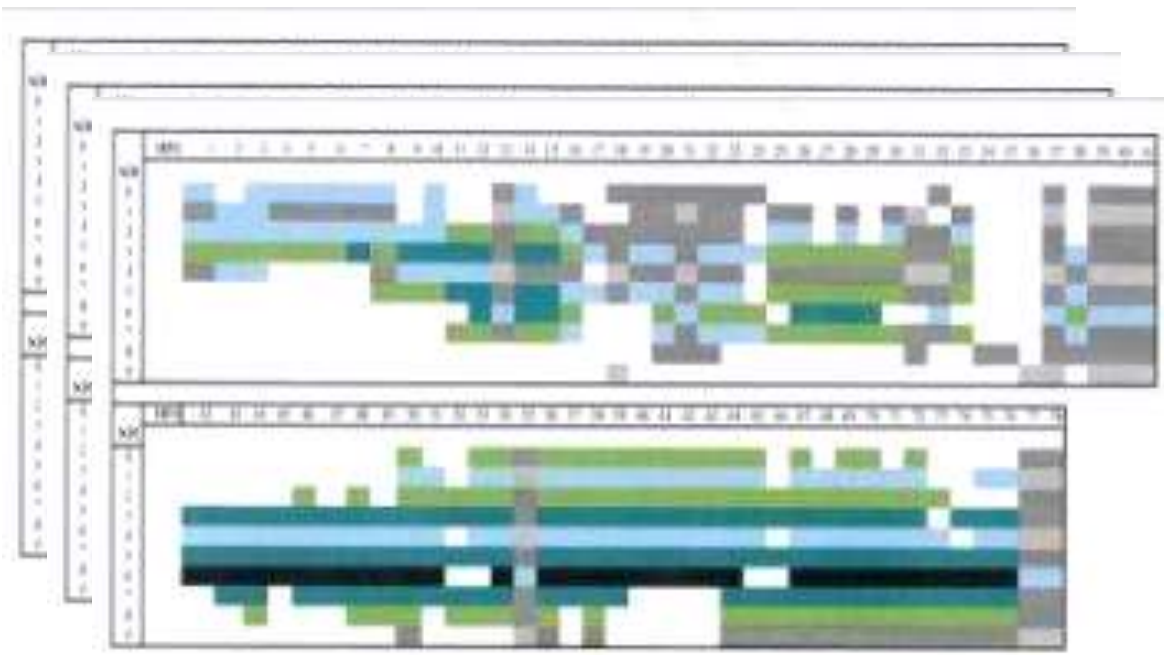
YY: main soil units (78)

(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)

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)

Examples of yield categories

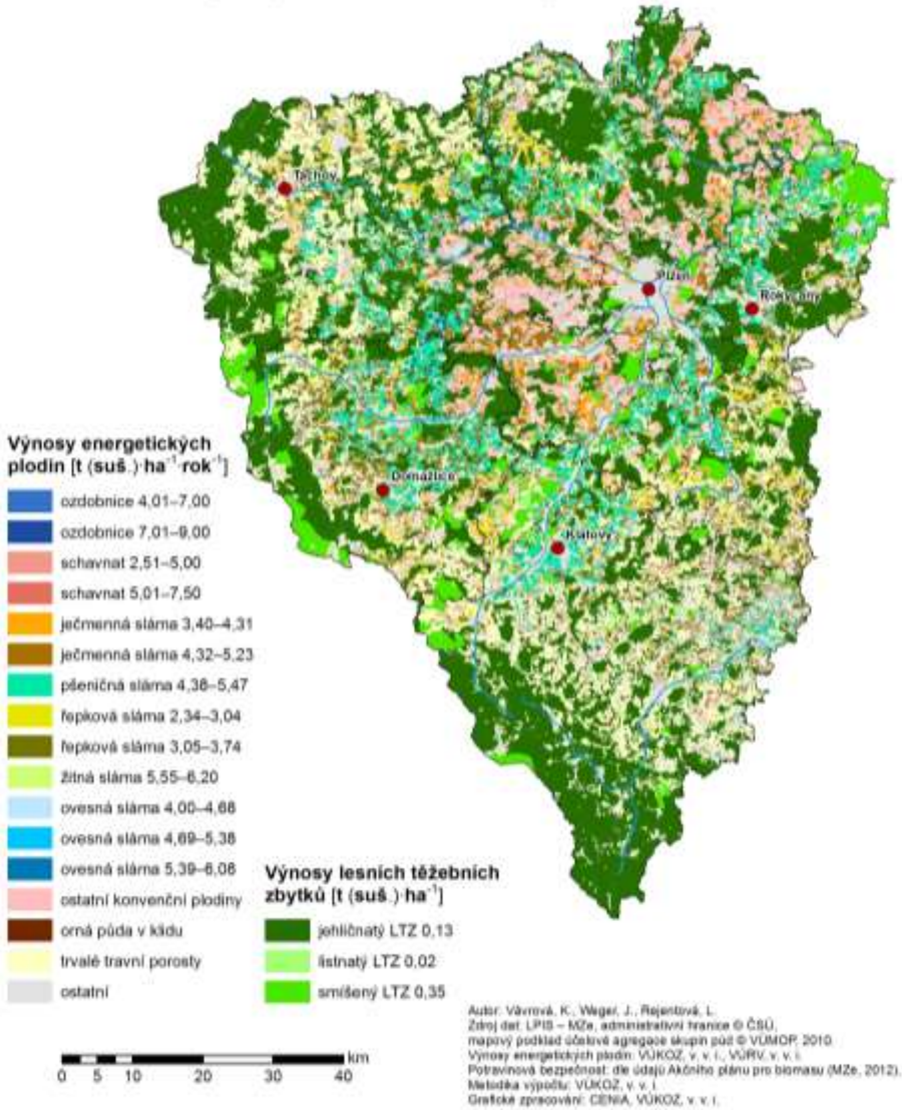
Yield cat.	**SRC** [t (DM).ha^{-1}]	**Miscanthus** [t (DM).ha^{-1}]	**Schavnat** [t (DM).ha^{-1}]	**Reed canary grass** [t (suš).ha^{-1}]
K1	< 5,01	<5,01	<2,51	<3,76
K2	5,01–7,00	5,01–9,00	2,51–5,00	3,76–5,25
K3	7,01–9,00	9,01–13,0	5,01–7,50	5,26–6,75
K4	9,0 1–11,00	>13,1	7,51–10,00	6,76–8,25
K5	11,01–13,00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

Biomass potential – modeling using GIS

Bottom-up approach

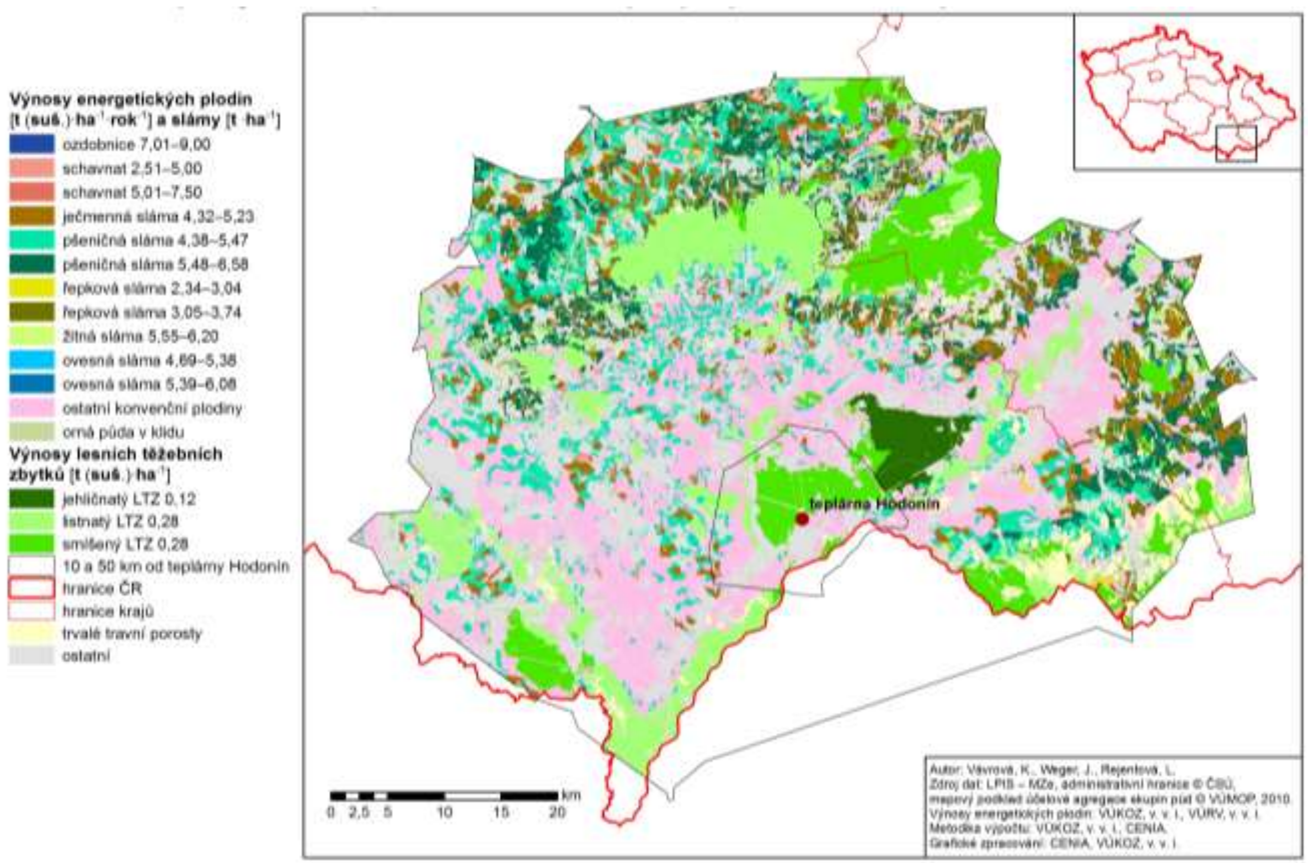
- Soil and climate conditions of individual land plots (registered in LPIS) – BPEJ (MSU) system of land valuation
- Determination of yields categories according to MSU
- Definition of analyzed region (incl. proportion of individual kinds of conventional crop, energy crop, environ. constraints, etc.)
- Similar approach applied to forests

Example of GIS modeling results



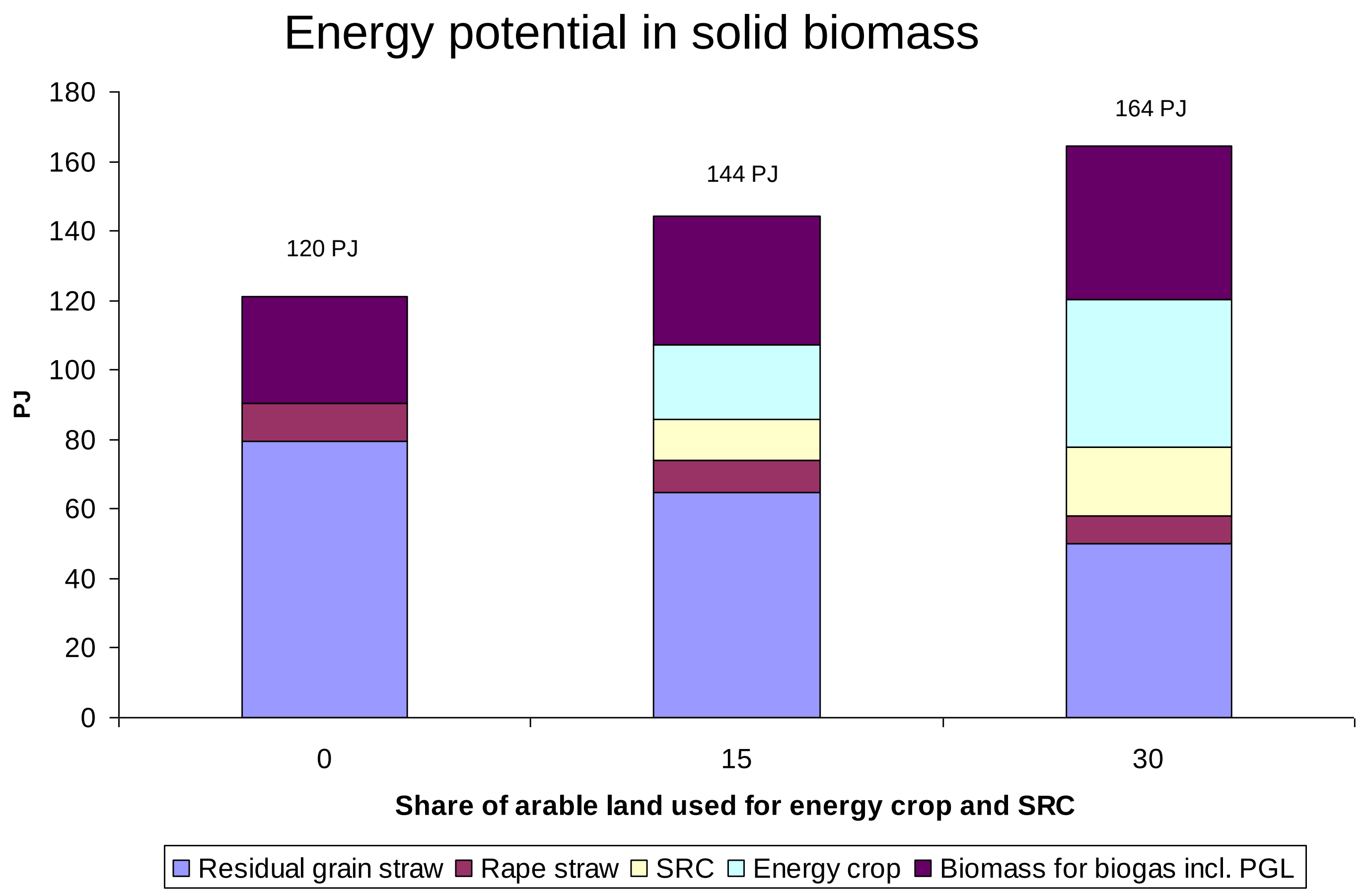
- ❑Preference of conventional production
- ❑Non linear function of biomass potential on land allocated for energy crop
- ❑Significant reduction of previous expectations – both on agr. land and forest land
- ❑Biomass potential can be determined as standard (long term) and additional (boosting in short term)

Example of GIS modeling results



GIS model enable inclusion of logistic routes in defined distance from given point (e.g. 10 and 50 km), losses in chain and economic parameters

Standard biomass potential as the function of land allocation for energy crop



Additional (short term) biomass potential

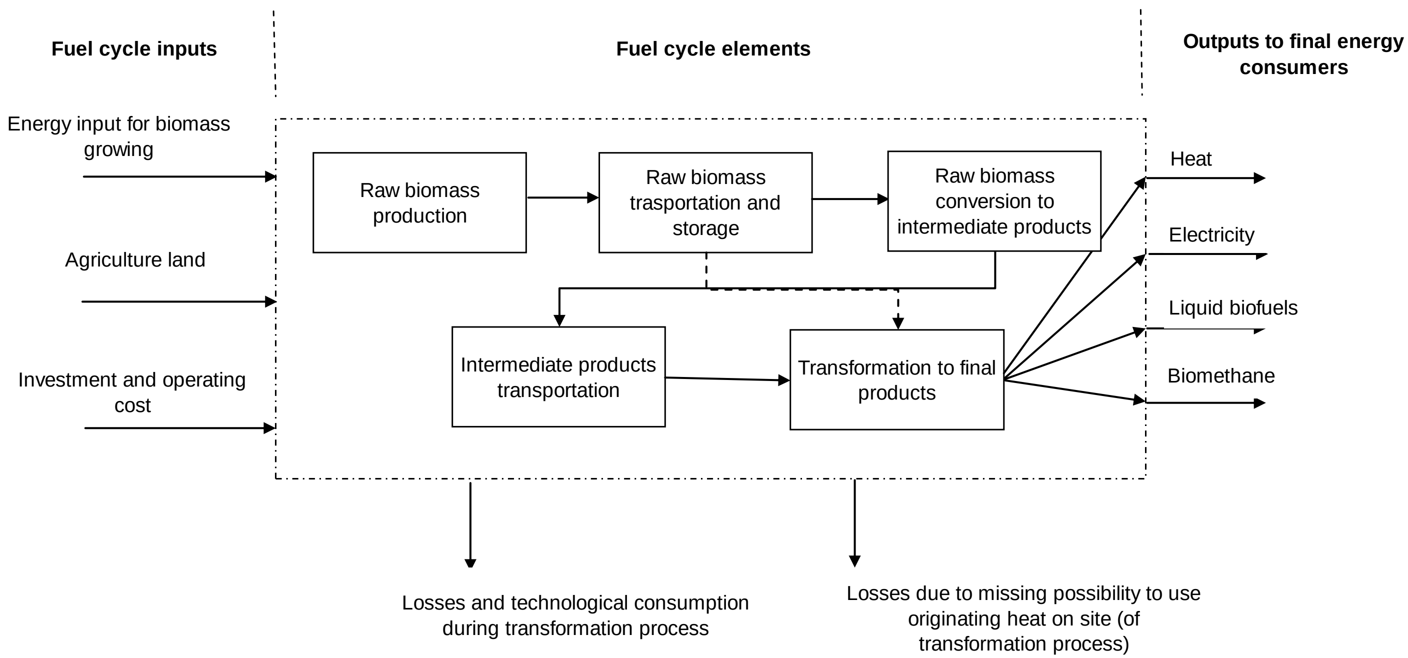
Sources of additional biomass potential

- 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

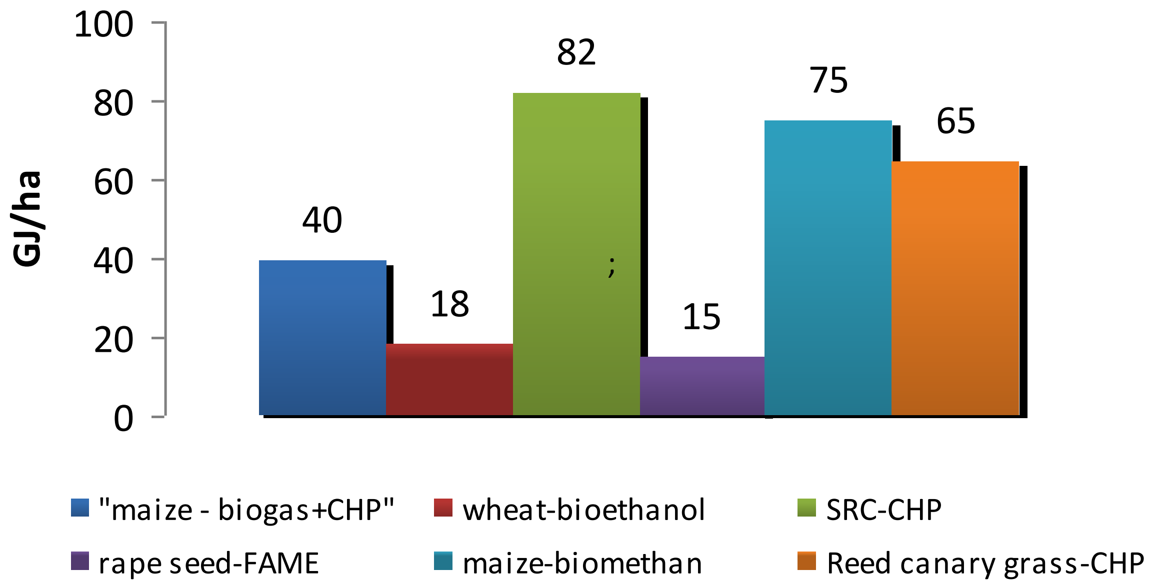
Land is scarce resource – question of energy effectiveness

Effectiveness of RES utilization – example of biomass fuel cycle



Land is scarce resource – question of energy effectiveness - 2

Effectiveness of RES utilization – comparison of net yields for different biomass cycles



Source: own calculation

Economic reality – biomass competitiveness

Three different points of view on biomass price

Producer's point of view:

Bottom acceptable price:

$$c_{bot} = \max(c_{min}; c_{alt})$$

C_{min}: minimum price derived from economic models – CF analysis, discount defines rate of return

C_{alt}: price of energy biomass ensuring the same economic effect as conventional production

Consumer's point of view:

Competitive price $\mathbf{c_{com}}$:

- ❑ derived from the effect of fossil fuel substitution with the biomass (or solid biofuels)
- ❑ depends on kind of substituted fuel, technology, subject, subsidy and other regulations
- ❑ can significantly differ from producers expectations

Conventional crop - straw

Rationality of decision makers

- ❑ Economic effect from land utilization (indifference between energy and conventional crop)
- ❑ High profitability of conventional crop pushes minimum price of biomass up

	Gross profit [th. CZK/ha]	Gross profitability [%]
Wheat (spring)	10.3	39
Barley (autumn)	6.2	35
Rye	9.5	62
Rape seed	10.6	41
Maize (corn)	13	51

Note: data for CR, average yields 2001-2011, commodity prices of 2011, cost of production accord. UZEI, SAPS incl.

Biomass competitiveness

Example of three points of view to biomass price for SRC (wood chips)

	c_{min} [CZK/GJ]	c_{alt} CZK/GJ	c_{com} CZK/GJ	c_{com}/* CZK/GJ
SRC	58-97	138-197	156	32

Note: Data for 2011, wood chips utilization for co-firing, GB scheme of support,

/* means no GB

Biomass potential is only informative value and its utilization requires creation of long term, favorable and stable conditions for energy biomass development !

Impact of logistic chains

Biomass potential is usually expressed as “on the field”, in real conditions:

- Losses during harvest, transportation and storage should be included
- Cost of transportation
- Related cost and losses influences minimum price of biomass
- Storage: one year cycle of biomass utilization (degradation, drying, …)
- Transportation: Distance of 10/50 km

Impact of logistic chains - 2

	Sorrel dock	Reed canary grass	Miscanthus	SRC
Impact of energy content losses [CZK/GJ]				
Harvest	1.3-2.7	1.7-4.3	1.8-7.7	2.7-8.2
Storage	3.3-7.1	4.4-11.3	4.7-20.0	3.0-9.1
Impact of biomass storage cost [CZK/GJ]				
	4.1	4.6	4.1	4.1
Impact of transportation [CZK/GJ,km]				
Tractor	1.3	1.4	1.3	1.1
Trailer	0.18	0.2	0.18	0.18
Impact of reloading to truck [CZK/GJ]				
	6.0	6.7	6.1	6.0

Inclusion of full logistic chain:

- Reduces energy content of biomass
- Increases minimum price of biomass
- SRC example: 24-58% increase of minimum price

Conclusions

1. Interpretation of biomass potential on agriculture land and from forests needs understanding of constraints applied (e.g. technical, environmental, legal, etc.)
2. Land is the only one really scarce resource – competition for land utilization (cannibal effect). Energy crop competes with conventional crop, wood chips from forests compete with material utilization of wood
3. Economically rational behavior of farmers and forest owners can be expected – e.g. high prices of conventional crop push up prices of energy biomass
4. Inclusion of environmental, legal, technical and other constraints significantly reduces “real” biomass potential
5. Biomass competitiveness is influenced by many factors on demand side (e.g. price of fuels, emission allowances, needed investment into technologies, etc.)
6. Inclusion of full logistic chain can significantly increase minimum price of biomass

Děkuji za pozornost!

Thanks for the attention !