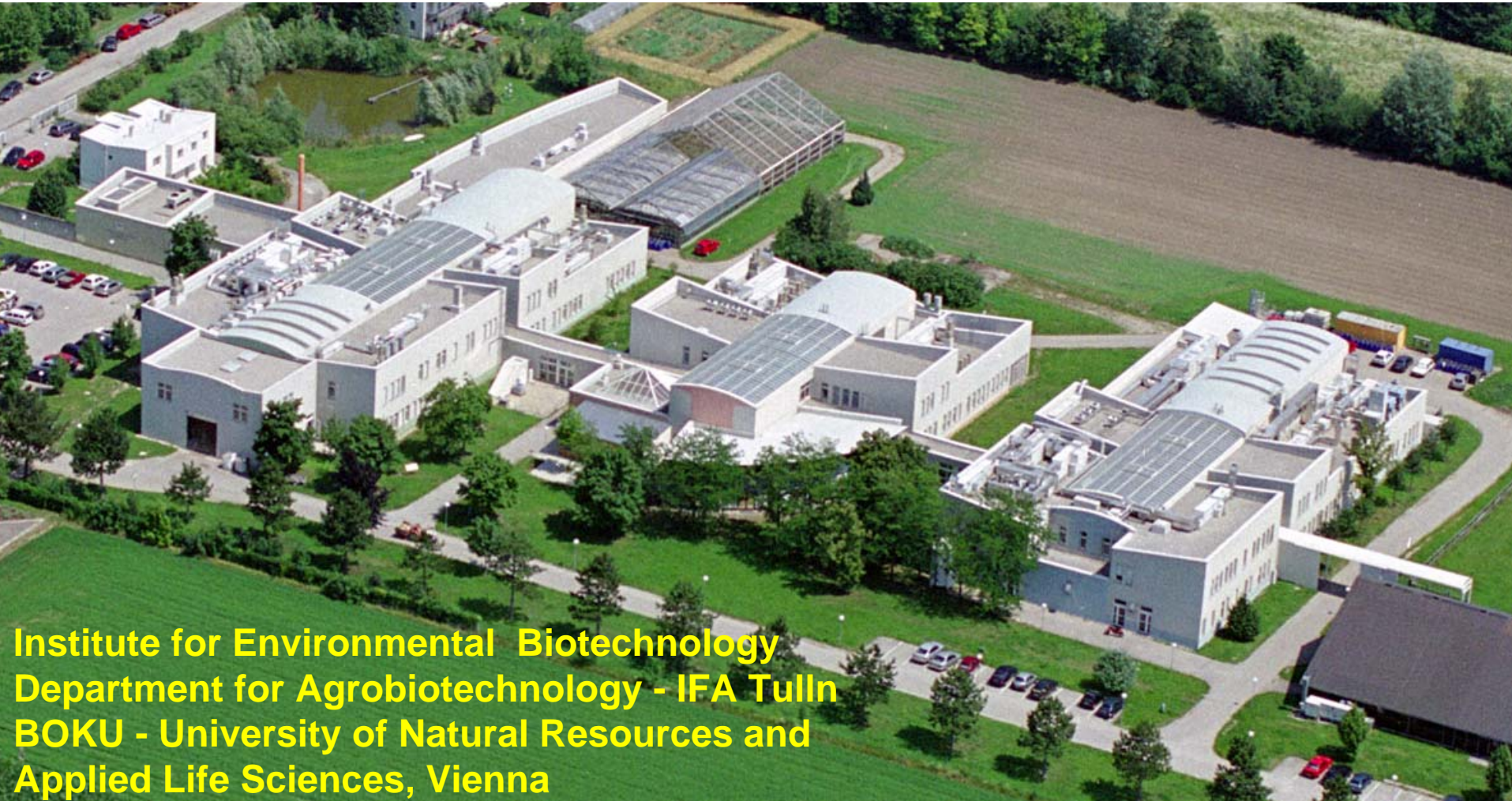


Country Update Austria - 2006

R. Braun 21. 4 .2006



**Institute for Environmental Biotechnology
Department for Agrobiotechnology - IFA Tulln
BOKU - University of Natural Resources and
Applied Life Sciences, Vienna**

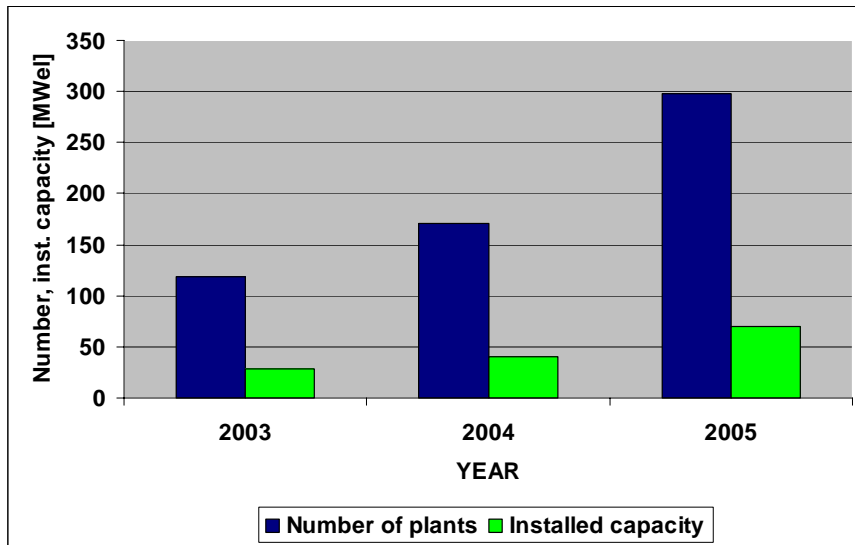


R. Braun

IEA Task 37 „Energy from Biogas and Landfill Gas“



Development of energy crop digestion in Austria



Austrian Eco Electricity Act (2002) Ökostromgesetz BGBl. I Nr. 2002/149

Inst. capacity (kW)	Feed-in tariff (€ct./kWh)*
< 100	16.5
100-500	14.5
500-1000	12.5
> 1,000	10.3

*) 25 % reduction in case of co-digestion of defined co-substrates; consent must be achieved by end of 2004

Amendment of the „ÖKOSTROMGESETZ“ 200?

- Overall limit to subsidies for Eco-electricity tariffs
- No fixed tariffs for solar-, wind-, biomass- etc.
(call for tenders)
- Decreasing subsidies (- 5 % per year)
- Distribution of subsidies: 40% biomass, 30% biogas, 20% wind, 10% photovoltaic
- Guaranteed for 10 years (before 13 years)
- New Eco-energy company to be founded for administration

Biogas Plants in Austria - April 2006

Source	Number of Plants	Mio m ³ Biogas per Year	% of Total Biogas
Landfills	62 Grey Waste - Landfill Gas Recov. Pl.	45-100	21.3
Sewage sludge	134 Sewage sludge digesters	75 - 100	25.8
Agriculture ¹	~350 Biogas- u. Co-Fermentation Plants	121 - 182	44.6
Industry ¹	25 Anaerobic Wastewater Treatment Pl.	9 - 14	3.4
Municipalities ¹	~15 Biowaste Digestion Plants	15 - 18	4.9
TOTAL		265 - 414	100

1) Estimation

Renewable Energy Sources in Austria

(Statistics Austria, 2001)

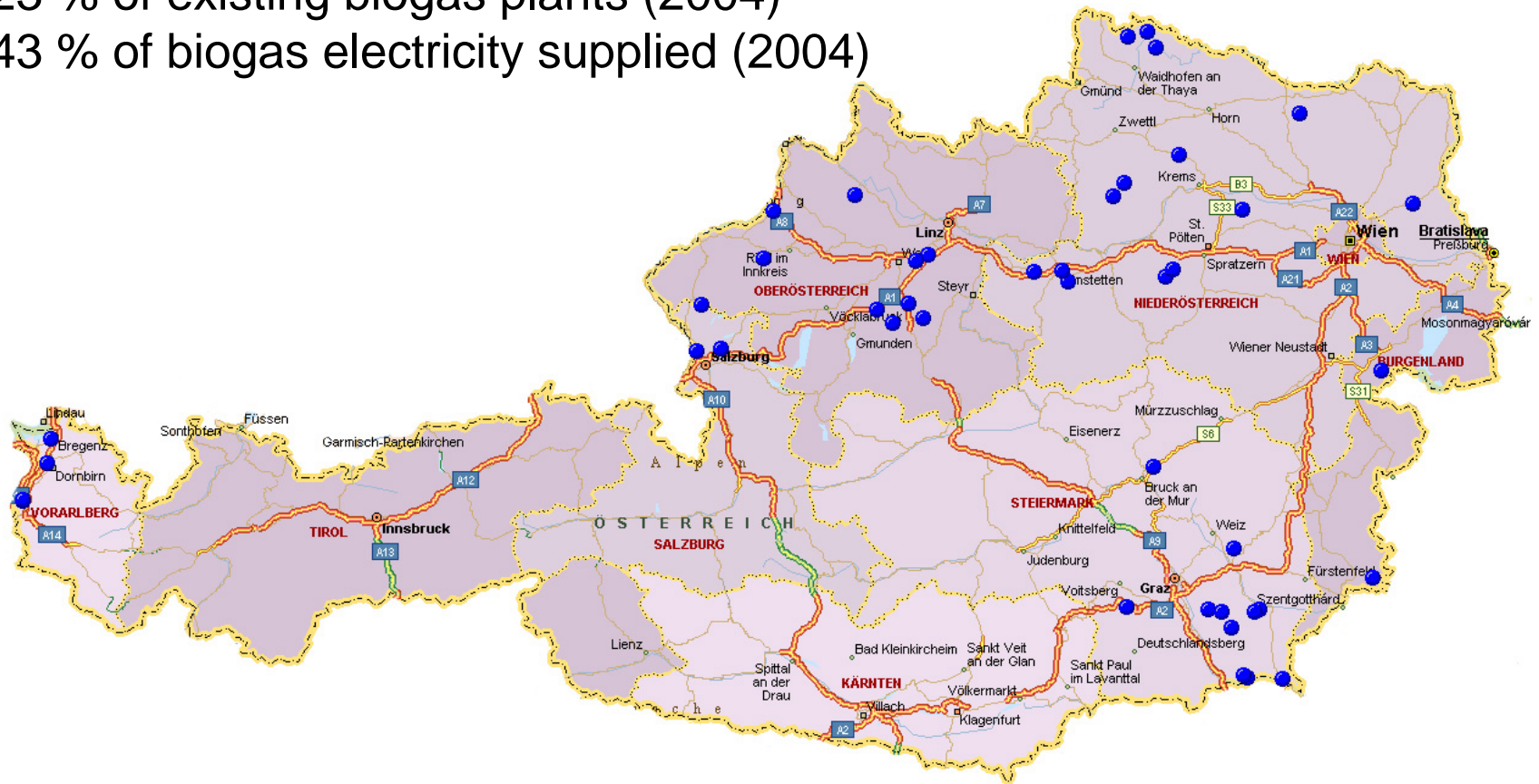
Hydropower	151 PJ \approx 11.6 % of PED ¹⁾
Others	142 PJ \approx 11 % of PED
Total PED in Austria	1,290 PJ
OTHERS	
Firewood	69.2 %
Industrial residual waste liquors	15.6 %
Combustible waste	7.3 %
Heat pump	4.9 %
Biogas, sewage gas, landfill gas	1.6 %
Straw	1.0 %
Wind- & solar energy	0.4 %
100,0 %	

¹⁾ Primary energy demand

Investigation of “Energy Crop” - Digestion Status in Austria by means of monitoring of a representative sample of 41 biogas plants

23 % of existing biogas plants (2004)

43 % of biogas electricity supplied (2004)



Parameters applied for evaluation of the biogas plants

General functional description	Measurable process conditions	Calculable variables
SUBSTRATE		
Quality / quantity Transport, Storage Pretreatment Costs	COD ¹ TKN ² , NH ₄ -N TS ³ , VS ⁴	t / year Costs/year
DIGESTER		
Startup Investment costs, Annual costs Subsidies Process steps, Substrate dosage Digester type Digester equipment Digester mixing	T, Self heating pH, VFA ⁵ , COD, TS, VS TKN, NH ₄ -N Process energy demand Sludge recirculation	Residence time Hydraulic loading VS degradation Biogas yield
DIGESTATE		
Storage type / cover Treatment / Dewatering Use	pH, COD, TS, VS VFA, TKN, NH ₄ -N, CH ₄ -formation Hygienic status	t / year
BIOGAS		
Quantity /utilisation Gas holder, Upgrading	CH ₄ , H ₂ S	Calorific value Electrical efficiency
PERSONNEL EXPENDITURE		
SALES REVENUES / OVERALL ECONOMICS		
ECOLOGICAL / SOCIO-ECONOMIC PERFORMANCE		

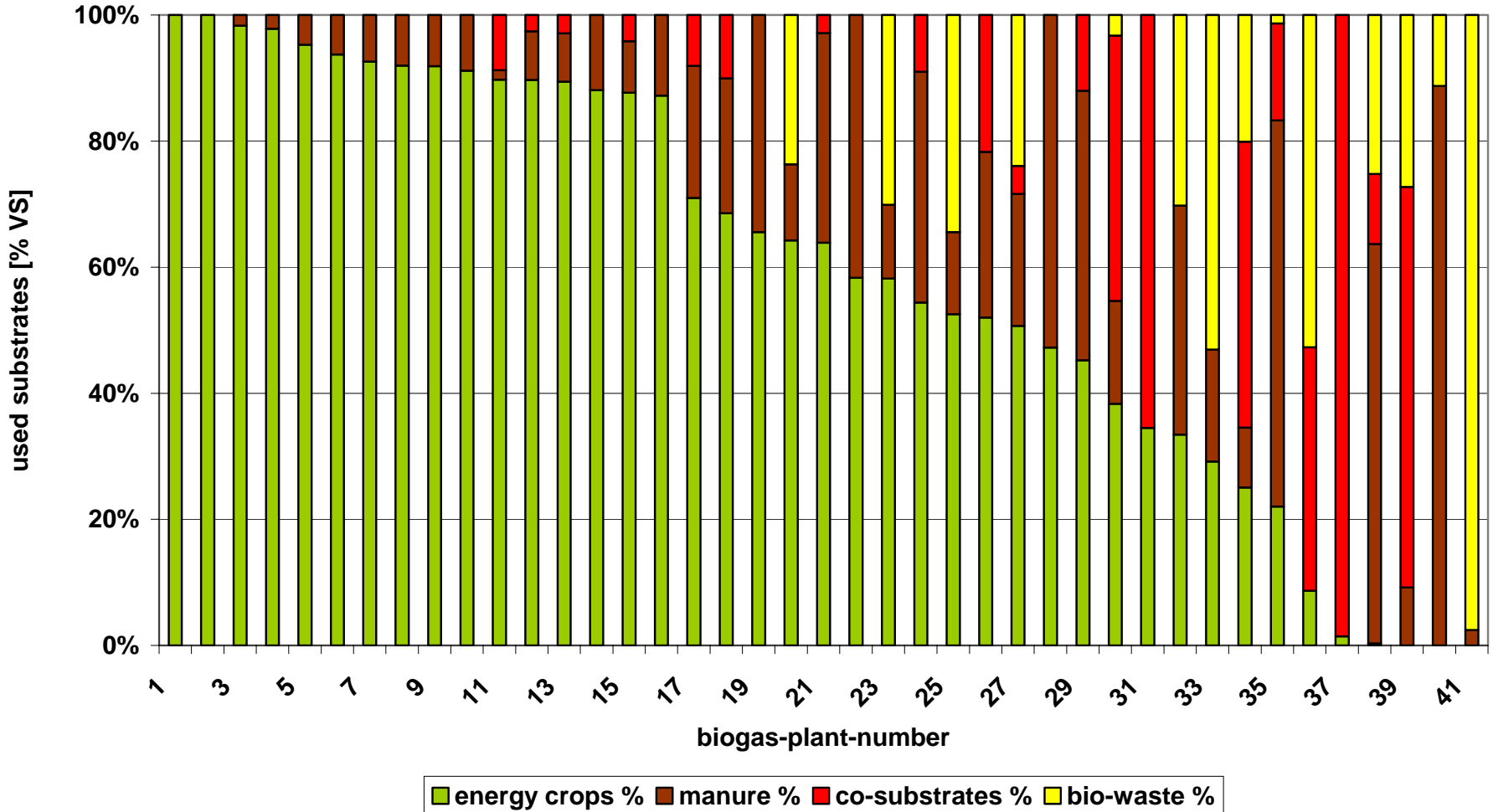
¹⁾ Chemical Oxygen Demand; ²⁾ Total Kjellidahl Nitrogen; ³⁾ Total Solids; ⁴⁾ Volatile Solids; ⁵⁾ Volatile Fatty Acids

Performance figures of the technical monitoring and benchmarking

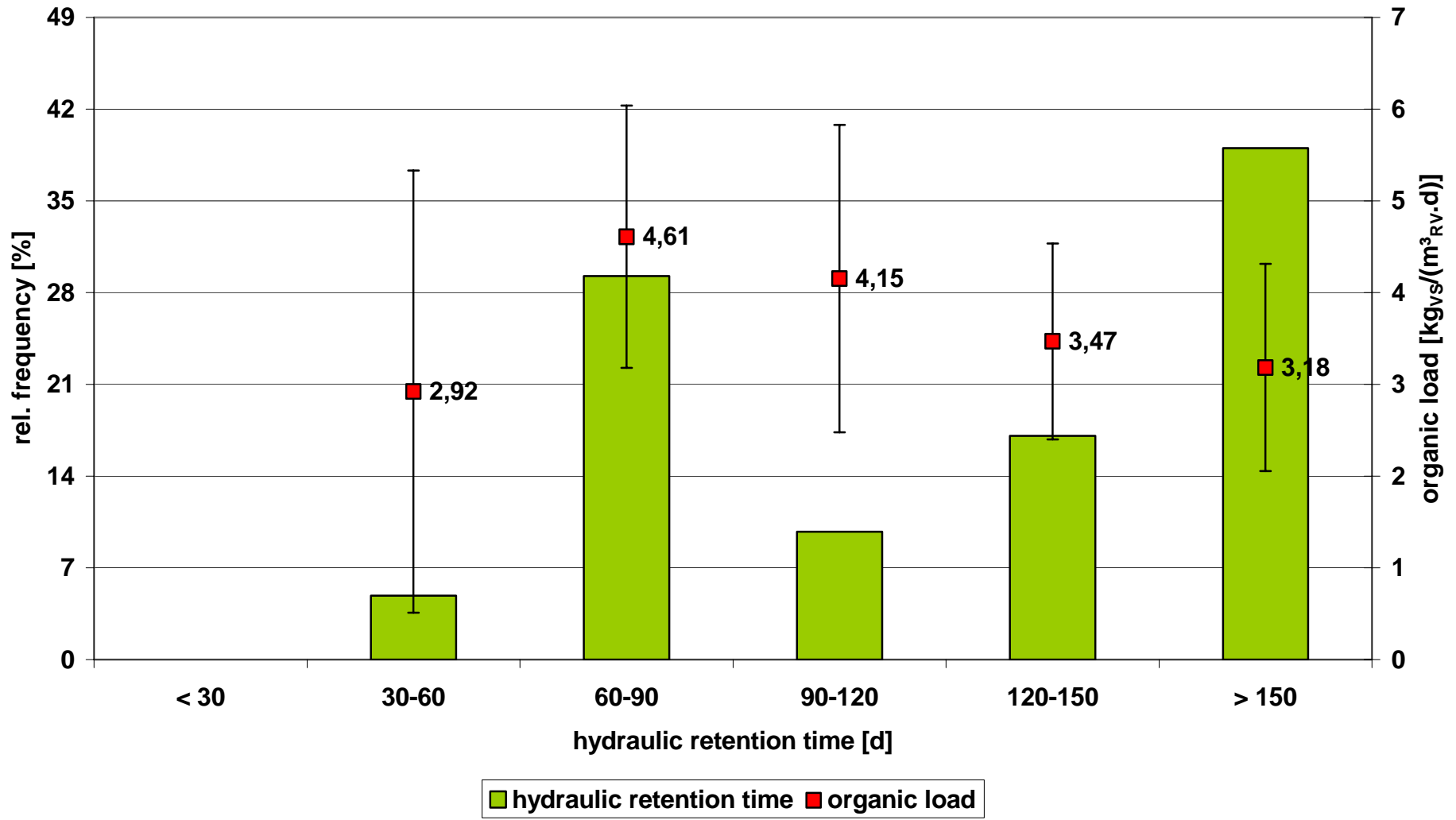
Parameter	Unit	Median ¹	min.	max.
Amount of processed substrate	$t_{\text{Substrate}}/\text{d}$	13.2	0.8	58.9
Hydraulic retention time	$\text{m}^3_{\text{RV}}/(t_{\text{Substrate}}/\text{d})$	131	44	483
Organic load (dry substance)	$\text{kg}_{\text{VS}}/(\text{m}^3_{\text{RV}}\cdot\text{d})$	3.59	1.04	7.97
COD load	$\text{kg}_{\text{COD}}/(\text{m}^3_{\text{RV}}\cdot\text{d})$	5.64	1.62	11.95
Amount of VS	t_{VS}/d	2.34	0.33	13.78
Biogas generation	$\text{Nm}^3_{\text{biogas}}/\text{d}$	1,461	233	10.115
Biogas productivity	$\text{Nm}^3_{\text{biogas}}/(\text{m}^3_{\text{RV}}\cdot\text{d})$	0.96	0.22	2.17
Carbon degradation	%	82.8	61.5	96.8
Average biogas yield	$\text{Nm}^3_{\text{biogas}}/\text{kg}_{\text{VS}}$	0.662	0.511	0.878
Methane content in biogas	%	54.8	49.7	67.0
Electrical efficiency	%	31.3	20.7	39.2
Use of heat (related to total input energy $H_{\text{u, biogas}}$)	%	16.5	0.0	42.6
Annual use efficiency (related to total input energy $H_{\text{u, biogas}}$)	%	47.3	30.5	72.3

RV: Reactor volume; $H_{\text{u, biogas}}$: Net calorific value of biogas; VS: Organic matter

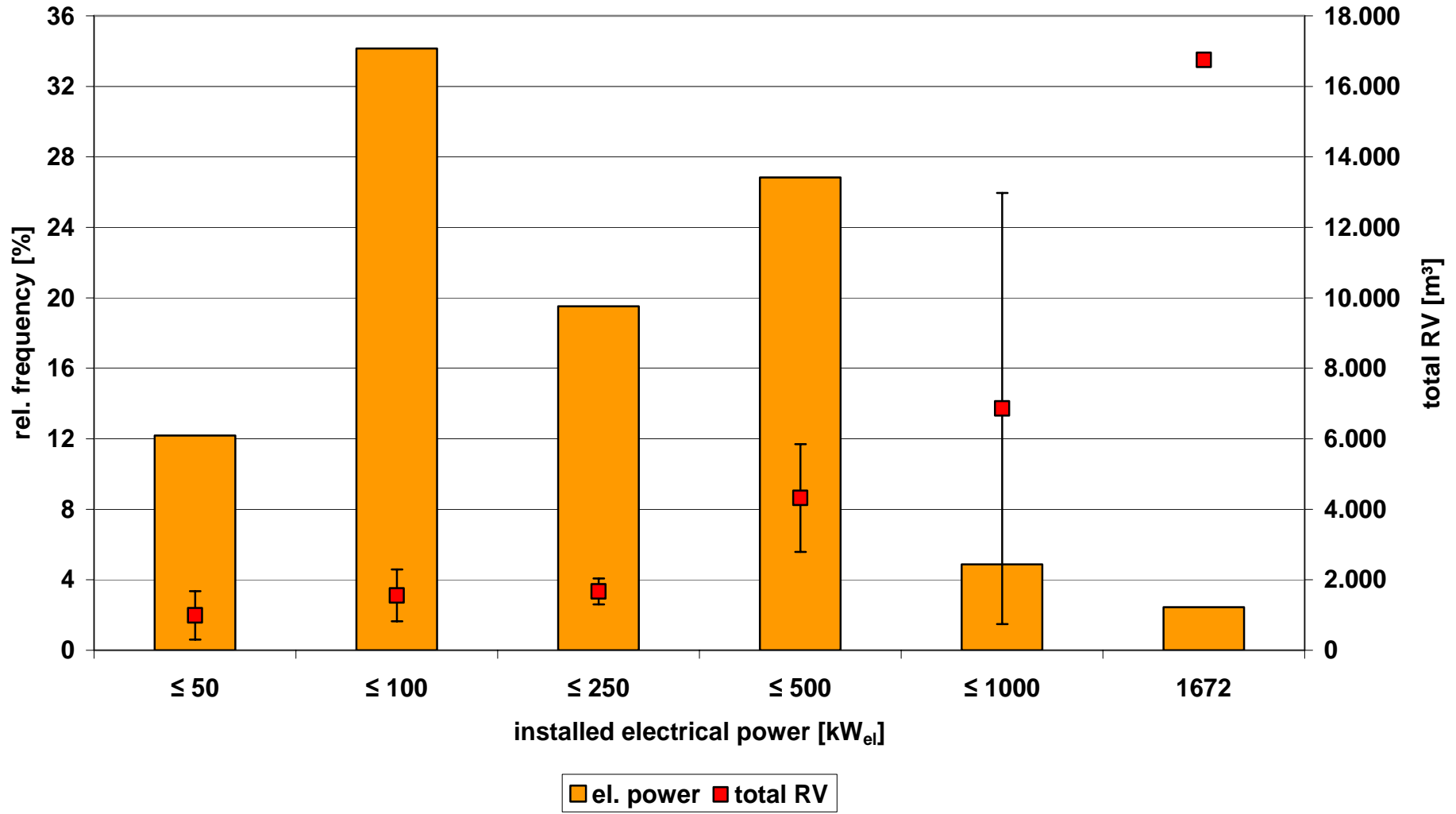
Used substrates (% VS)



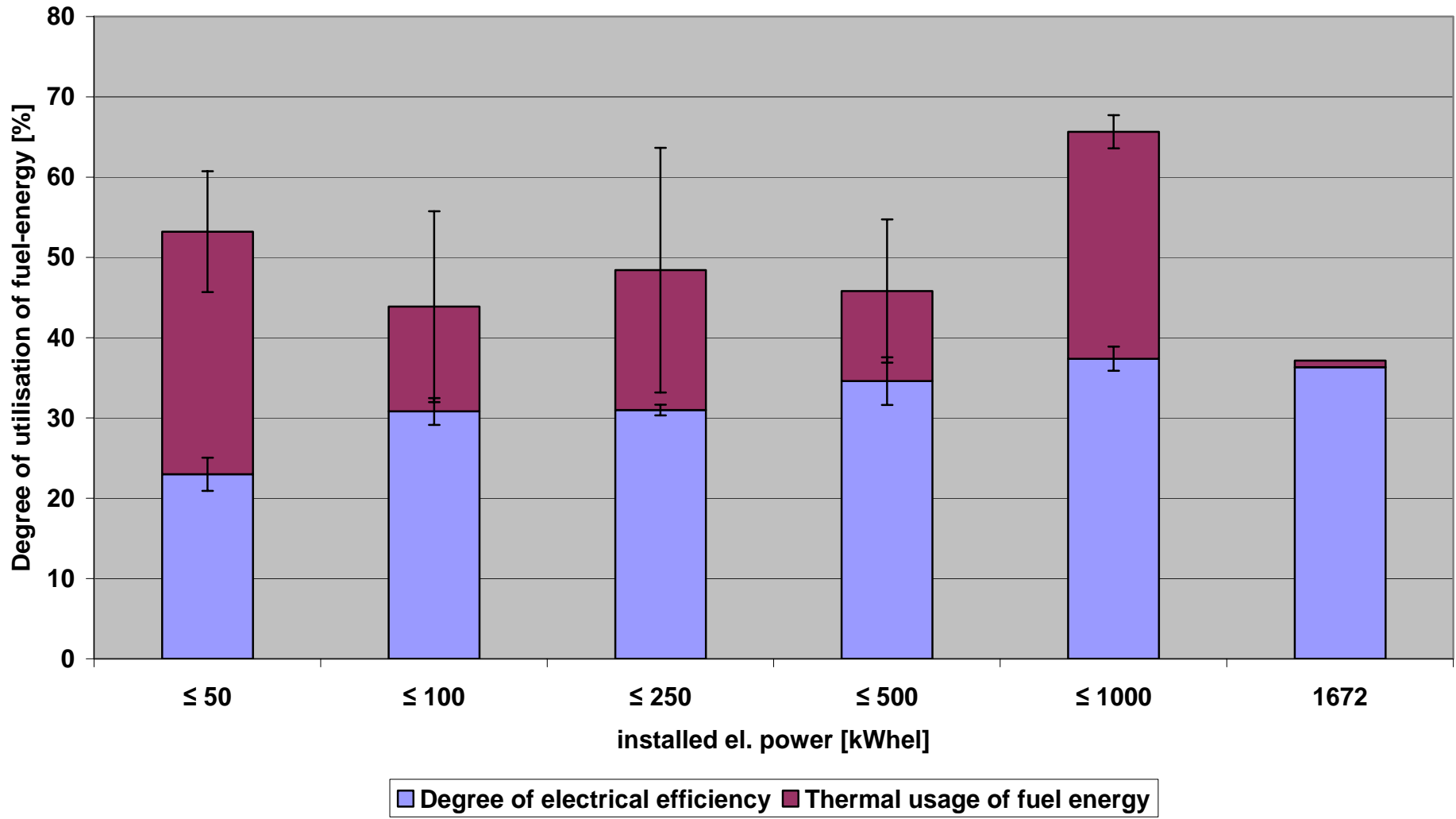
Hydraulic retention time and organic load



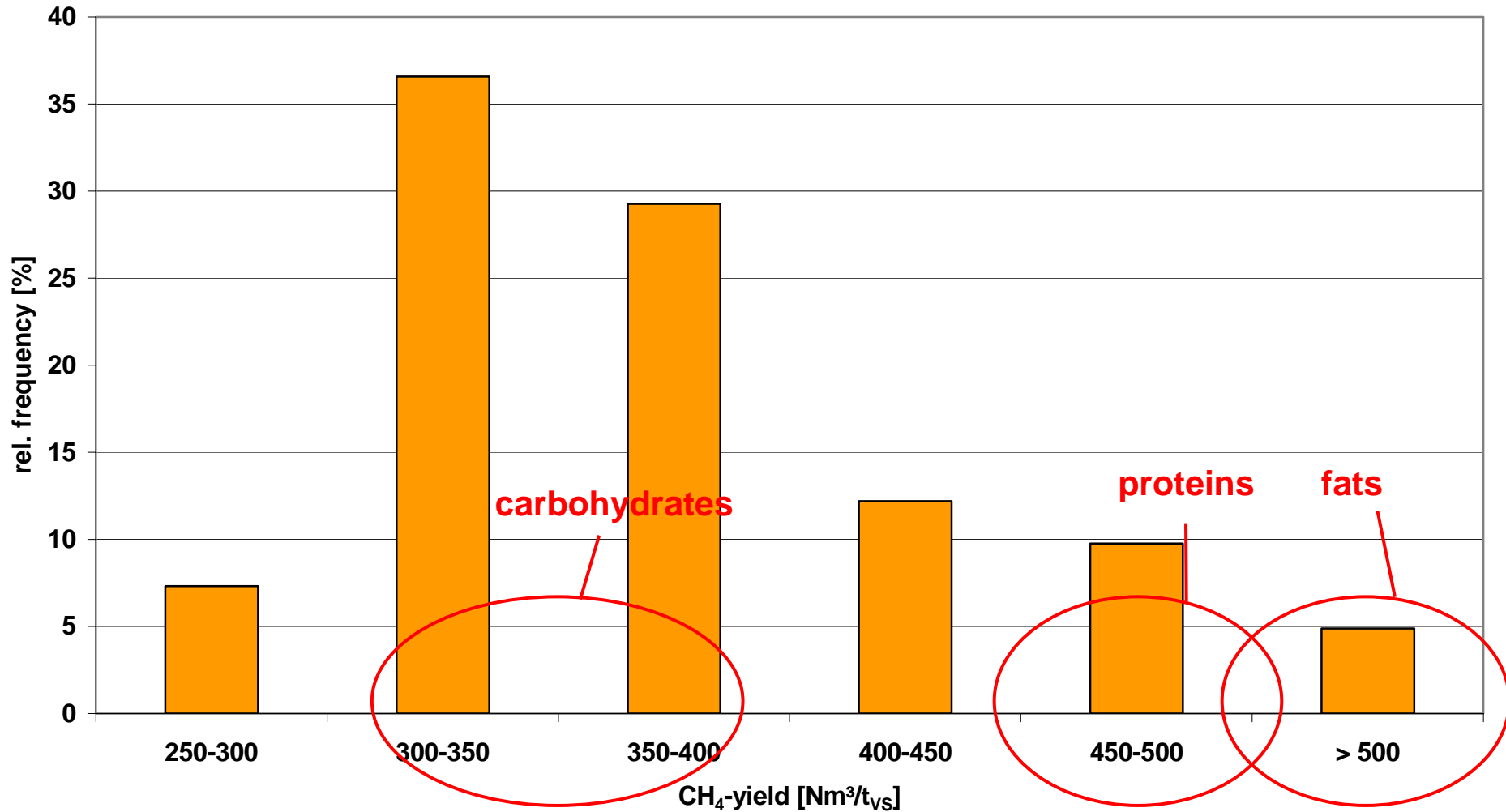
Plant size (kW_{el}) and reactor volume (RV)



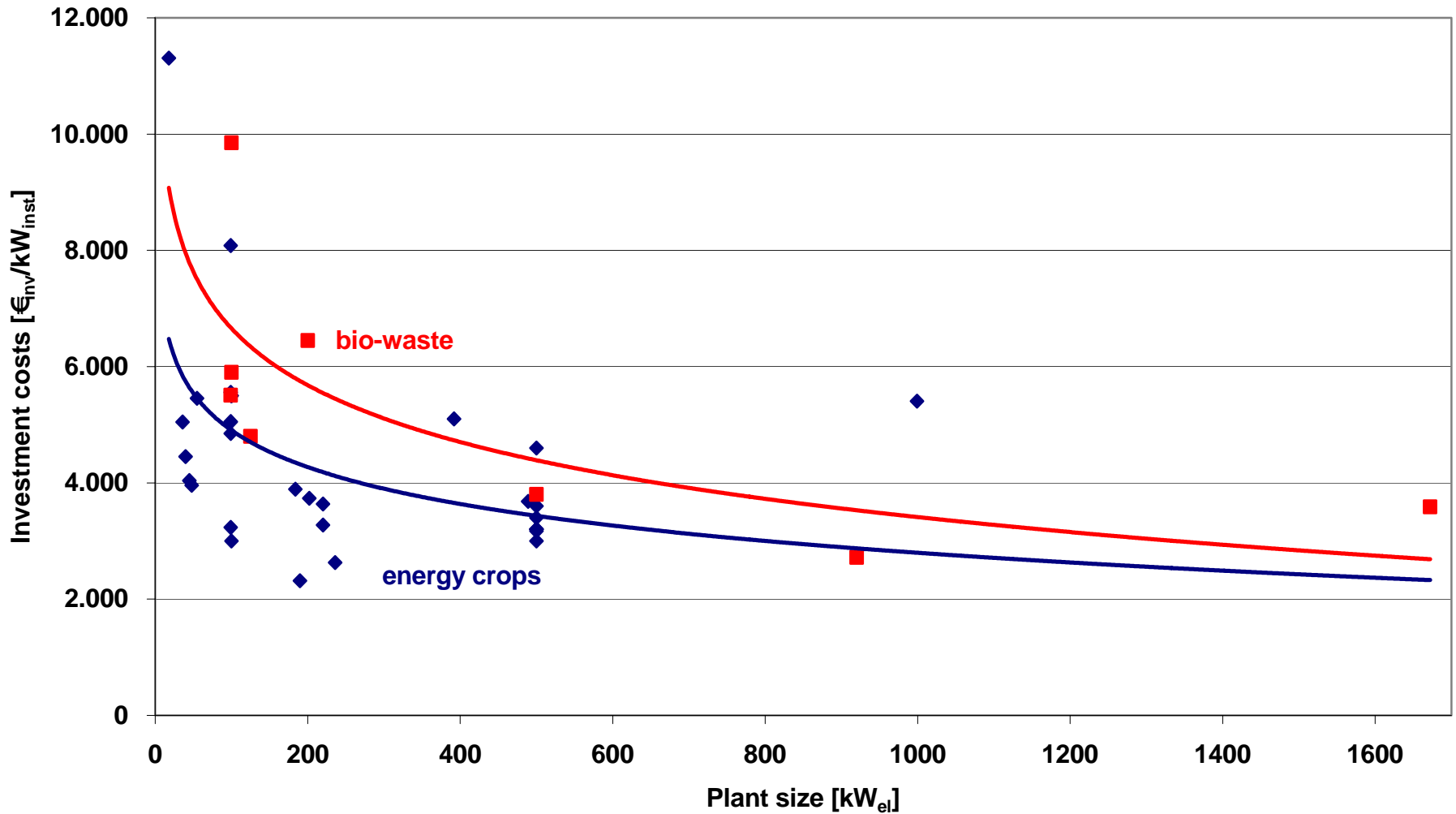
Utilisation of fuel energy



Methane-yield [VS]



Investment costs

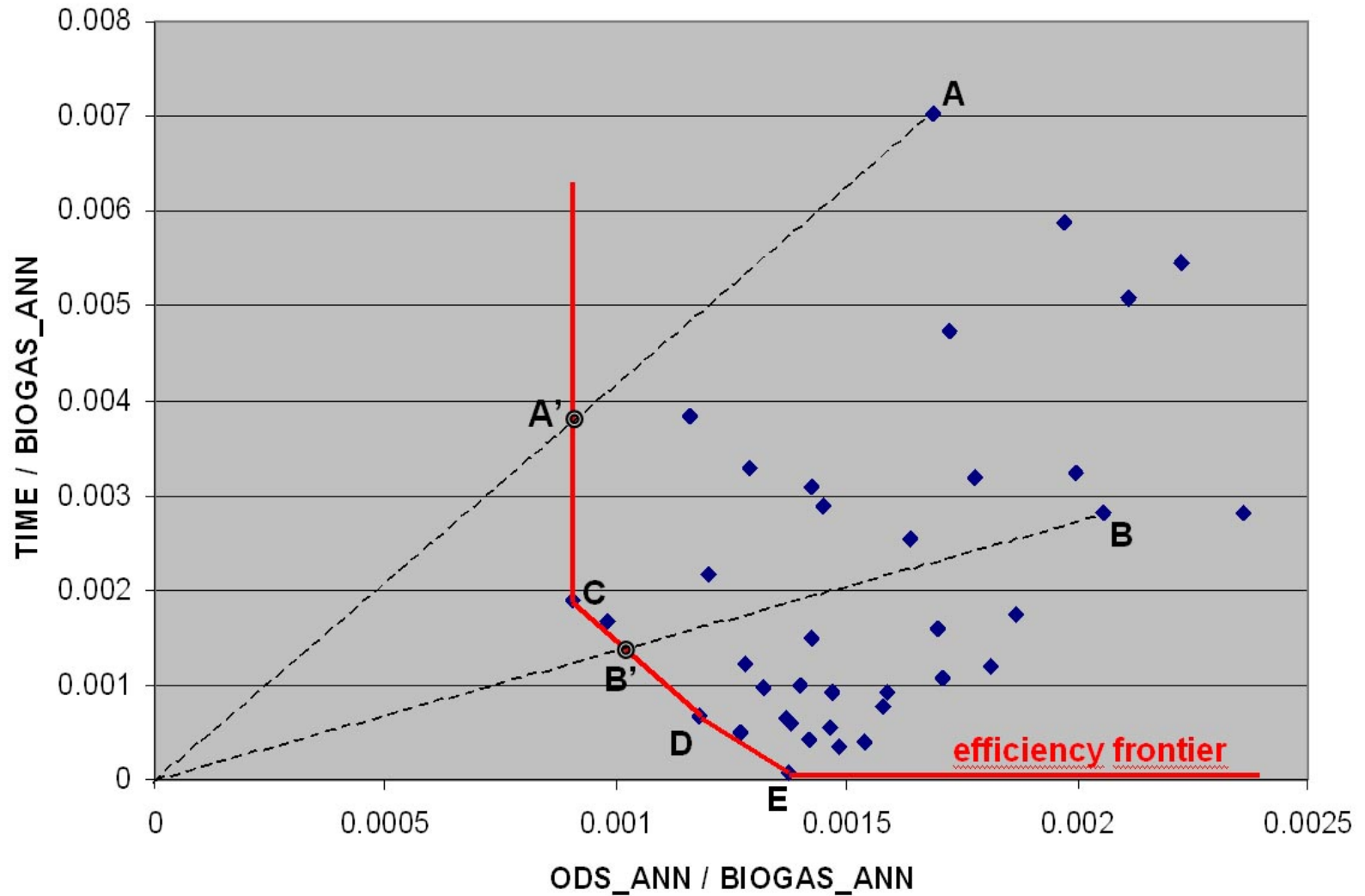


Benchmarking by means of Data Envelopment Analysis (DEA)

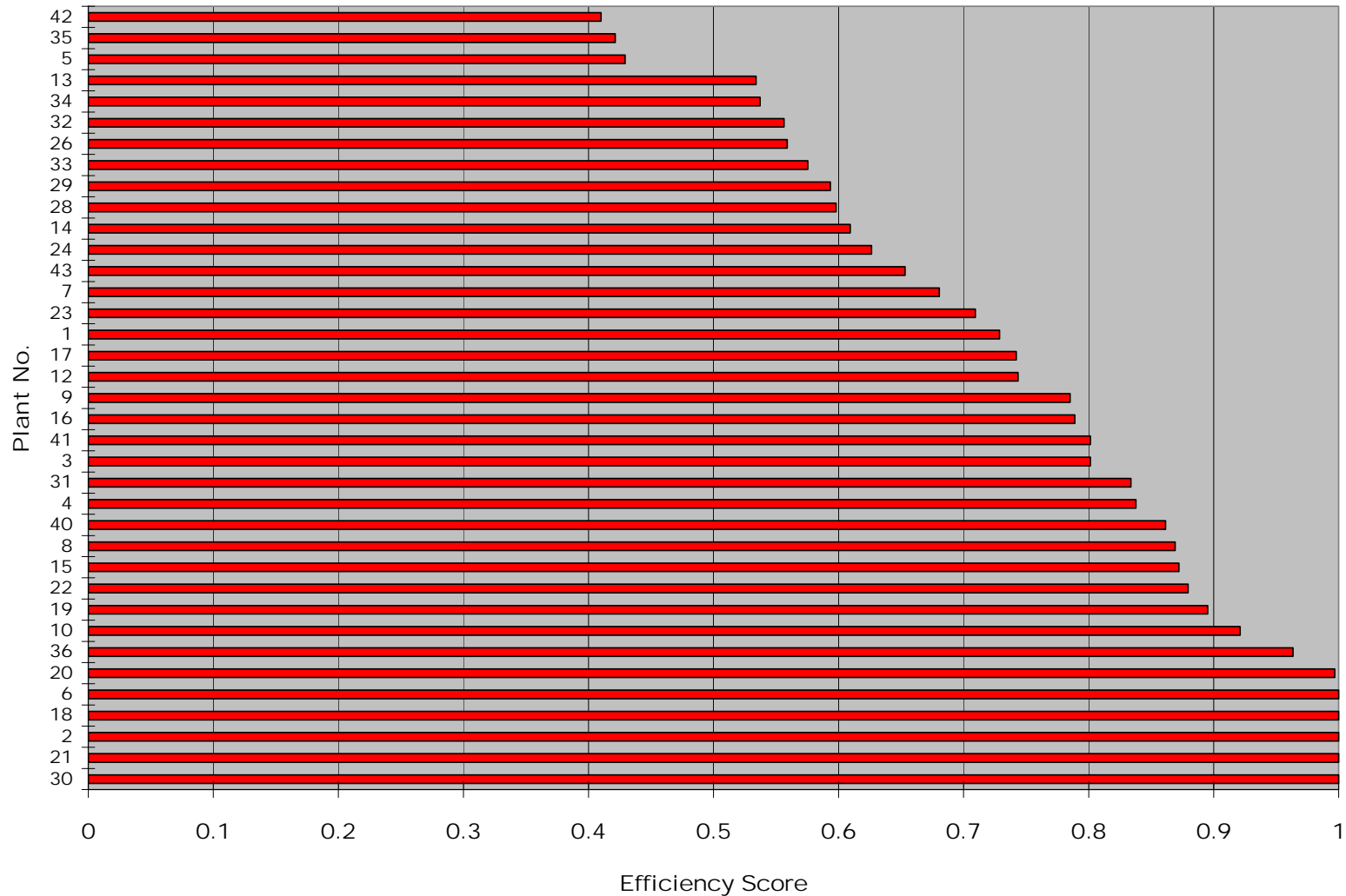
- Best practise benchmarking model
- Non-parametric linear programming tool
- Comparative efficiency measurement
- Production efficiency frontier



Efficiency frontier

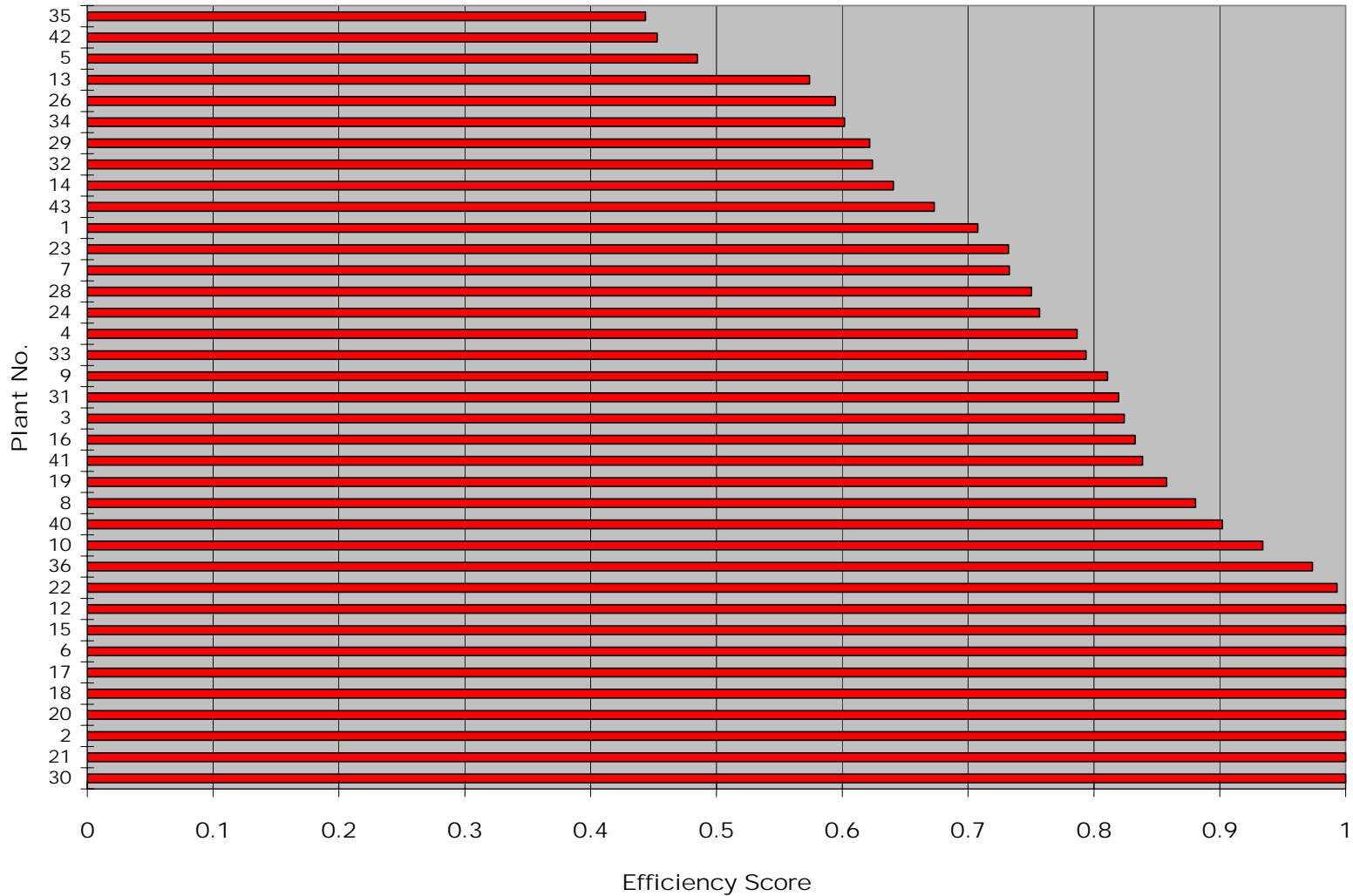


Relative efficiency I



(inputs used: amount of organic dry substance, time effort; outputs used: net electricity production and total heat production)

Relative efficiency II



(inputs used: organic dry substance and time effort; outputs used: electricity fed into the grid, total heat production)

CONCLUSIONS

- **Reasons for specifically good or poor performing digestion plants must be further investigated in detail**
- **Environmental- (ecologic) and socio-economic impacts of energy crop digestion must be thoroughly investigated and considered**
- **Experiences from best practice biogas plants can prevent poor technological development and wrong investment / subsidies decisions**

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