

## Etanol och biogas ur cellulosarika avfall

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Centrum för optimal resurshantering av avfall

[www.wasterefinery.se](http://www.wasterefinery.se)

## Utbildning om "Resursåtervinning"



### Masterutbildning:

Resource Recovery- Industrial Biotechnology  
Resource Recovery- Sustainable Engineering

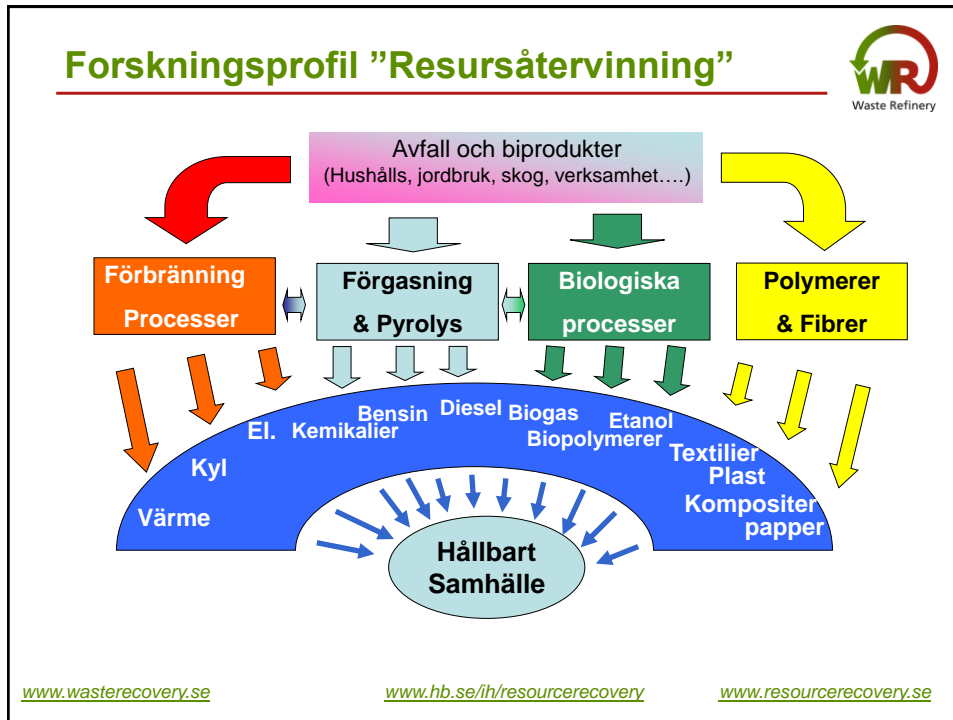
### Forskarutbildning:

Resource Recovery

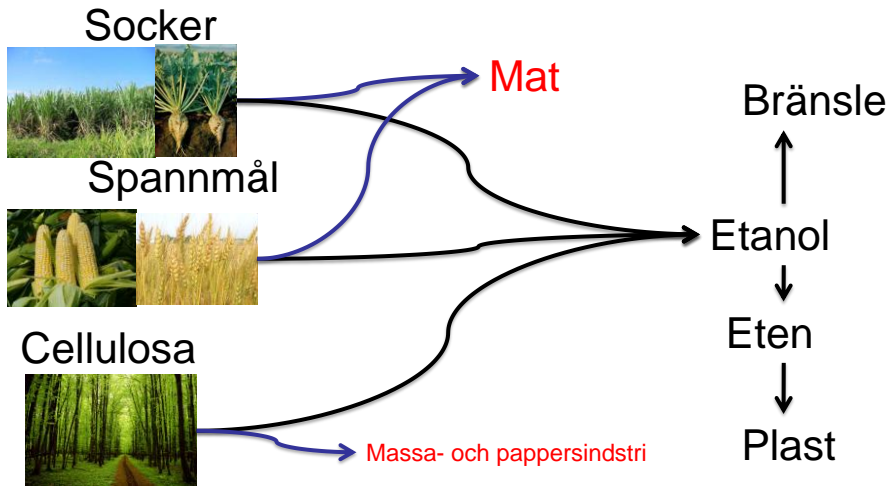
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## 1:a och 2:a generationer etanol

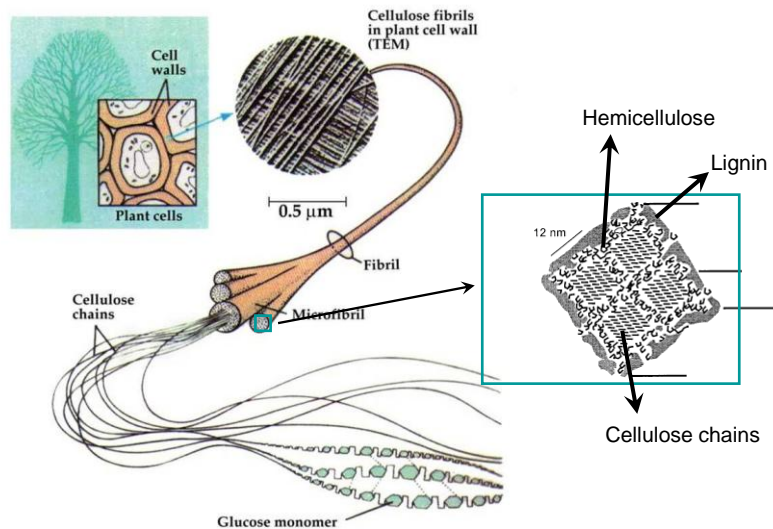


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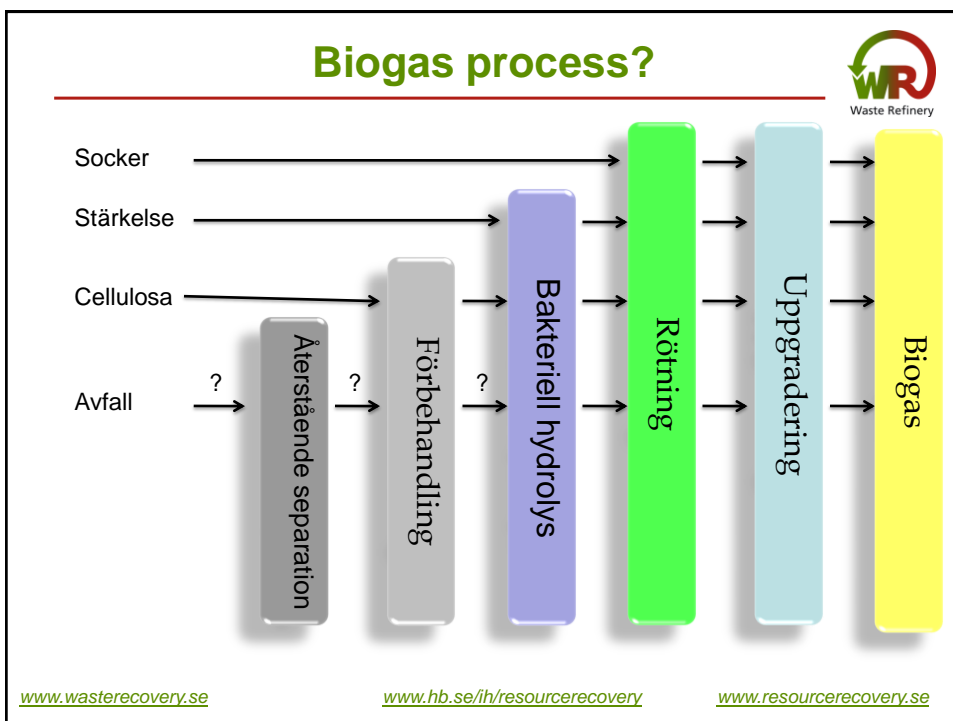
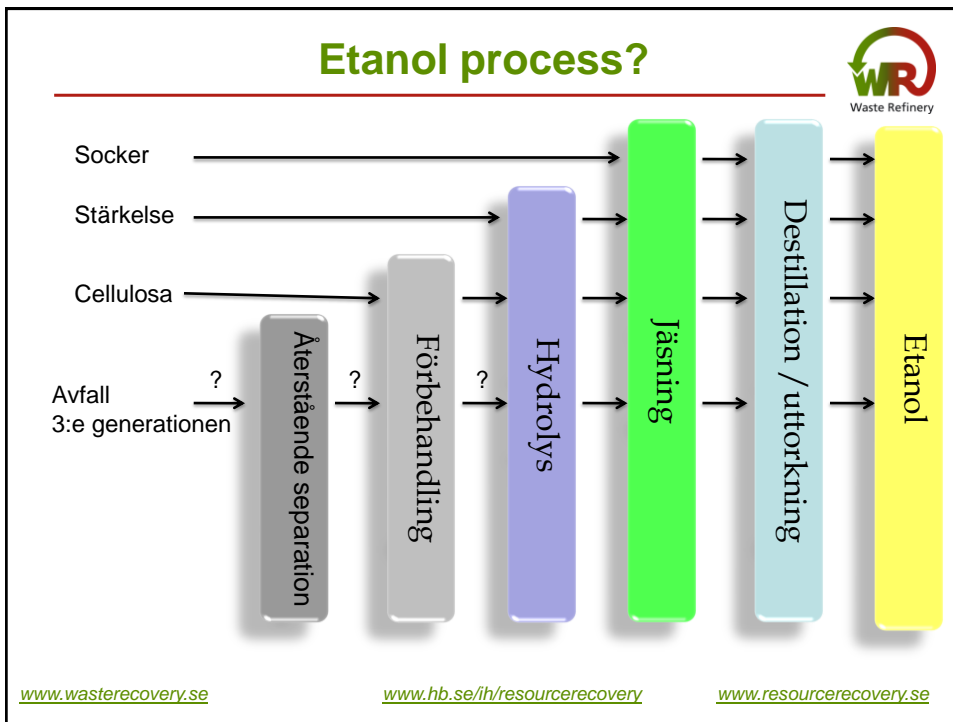
## Lignocellulosa struktur



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## (Hemi)cellulosa i skogrestprodukter



Sockerpolymerer (%)

Material	Glucan	Mannan	Galactan	Xylan
<b><u>Lövved</u></b>				
Al	40.5	1.5	0.8	16.1
Asp	43.2	2.2	0.5	15.1
Björk	40.7	1.7	0.7	20.0
<b><u>Barrved</u></b>				
Tall	42.4	11.8	1.9	4.7
Gran	41.6	11.5	2.0	4.7

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## Avfall från cellulosa:



**Ved + Metaller + färger = Pall**



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## Avfall från cellulosa:



### Toxiska cellulosa

Yields of the carbohydrates released during enzymatic hydrolysis of the orange peels.



Carbohydrate	% (of total solid)	
Glucose	22.9 ± 2.4	<b>hemicellulose</b>
Fructose	14.1 ± 1.3	
Galactose	4.0 ± 0.2	<b>hemicellulose</b>
Arabinose	7.1 ± 0.5	
Xylose	0.4 ± 0.1	
Galacturonic acid	19.0 ± 1.7	<b>pectin</b>
Total	67.5	

*Int. J. Mol. Sci.* **2007**, 8



Limonen ca 0.5%

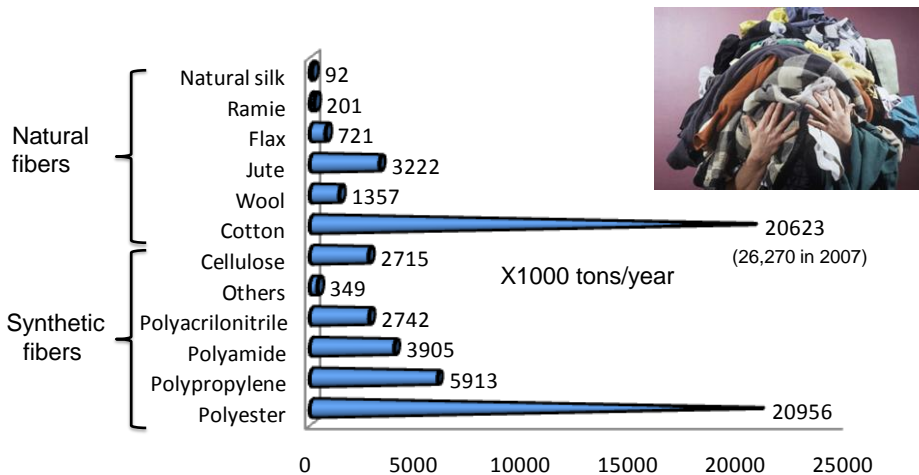
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## Textilavfall i världen

(Utmaningar: Blandning & svåra nedbrytbara!)



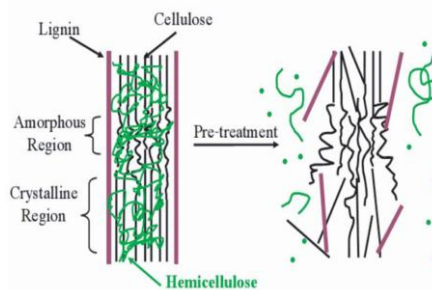
Ref: Aizenshtein, E.M., 2004. World production of textile raw materials in 2002. *Fibre Chem.* 36, 1-6

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## Förbehandling?



- ✓ Ta bort förhinder (tex lignin)
- ✓ Minska kristallinitet
- ✓ Tillhandahålla tillräckligt tillgänglig yta att absorbera enzymer

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## Många metoder för förbehandling



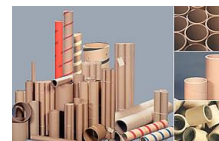
Physical methods	Chemical & Physicochemicals	Biological
<b>milling:</b> - Ball milling - Two-roll milling - Hammer milling - Colloid milling - Vibro energy milling <b>irradiation:</b> - Gamma-ray irradiation - Electron-beam irradiation - Microwave irradiation <b>Others:</b> - Hydrothermal - High pressure steaming - Expansion - Extrusion - Pyrolysis	<b>Explosion:</b> - Steam, Ammonia, CO <sub>2</sub> , SO <sub>2</sub> , Acids <b>Alkali:</b> - NaOH, NH <sub>3</sub> , (NH <sub>4</sub> ) <sub>2</sub> SO <sub>3</sub> <b>Acid:</b> - Sulfuric, Hydrochloric & Phosphoric acids <b>Gas:</b> - ClO <sub>2</sub> , NO <sub>2</sub> , SO <sub>2</sub> <b>Oxidizing agents:</b> - Hydrogen peroxide - Wet oxidation - Ozone <b>Solvent extraction of lignin:</b> - Ethanol-water extraction - Benzene-water extraction - Ethylene glycol extraction - Butanol-water extraction - Swelling agents <b>Organosolvents/ Ionic liquids</b>	<b>Fungi and actinomycetes</b>

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## Vi jobbar på olika material

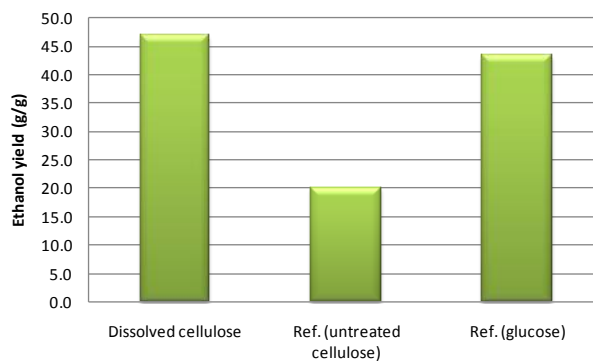


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## Etanol produktion från hög kristallin cellulosa



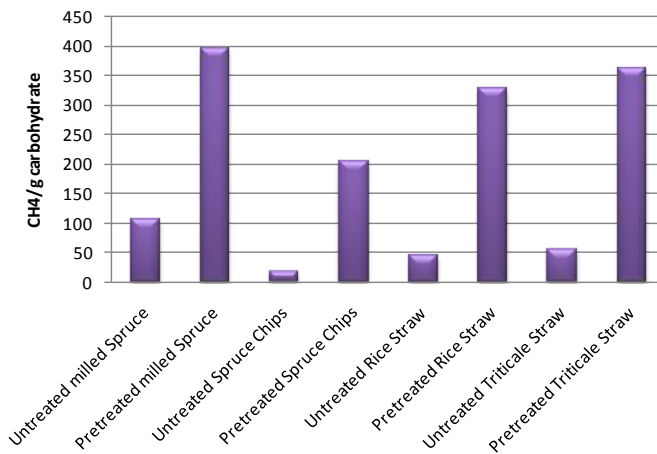
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## Förbättrad biogas (CH<sub>4</sub>) produktion efter förbehandling

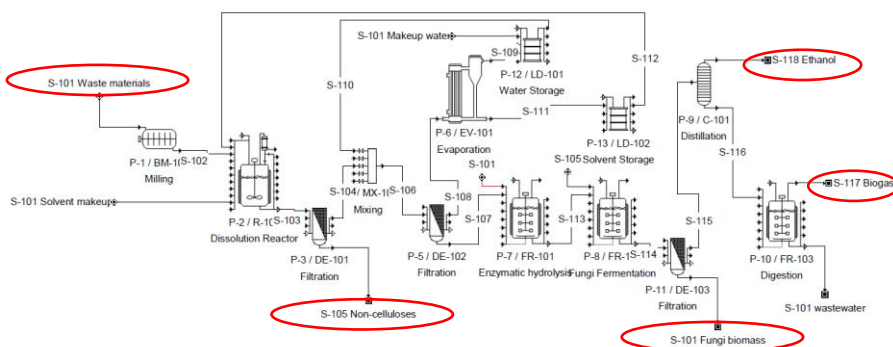


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## Vårt koncept för en testprocess!



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## Sammanfattning

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- Olika cellulosa avfall kräver olika förbehandlingsmetoder, men resten av processen är praktiskt taget densamma,
- Avfallsflöden kan integreras i framtida etanolanläggningar,
- Biogas från cellulosa avfall kan framställas av en två-stegs process inklusive förbehandling och rötning.

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## Tack!

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## Frågor?

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