

# Gas production potential forest industry residues

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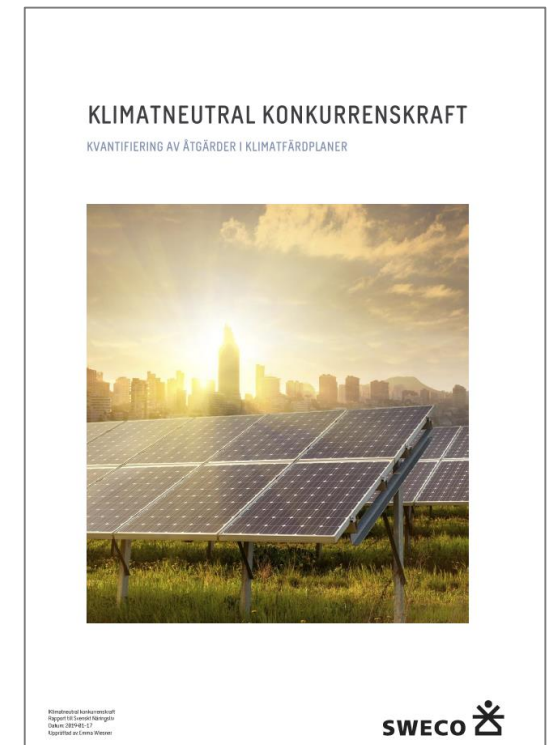
# Agenda

- The big picture: What is needed and what can be made available by 2045
- How can we reach the goal
- What are the most important steps

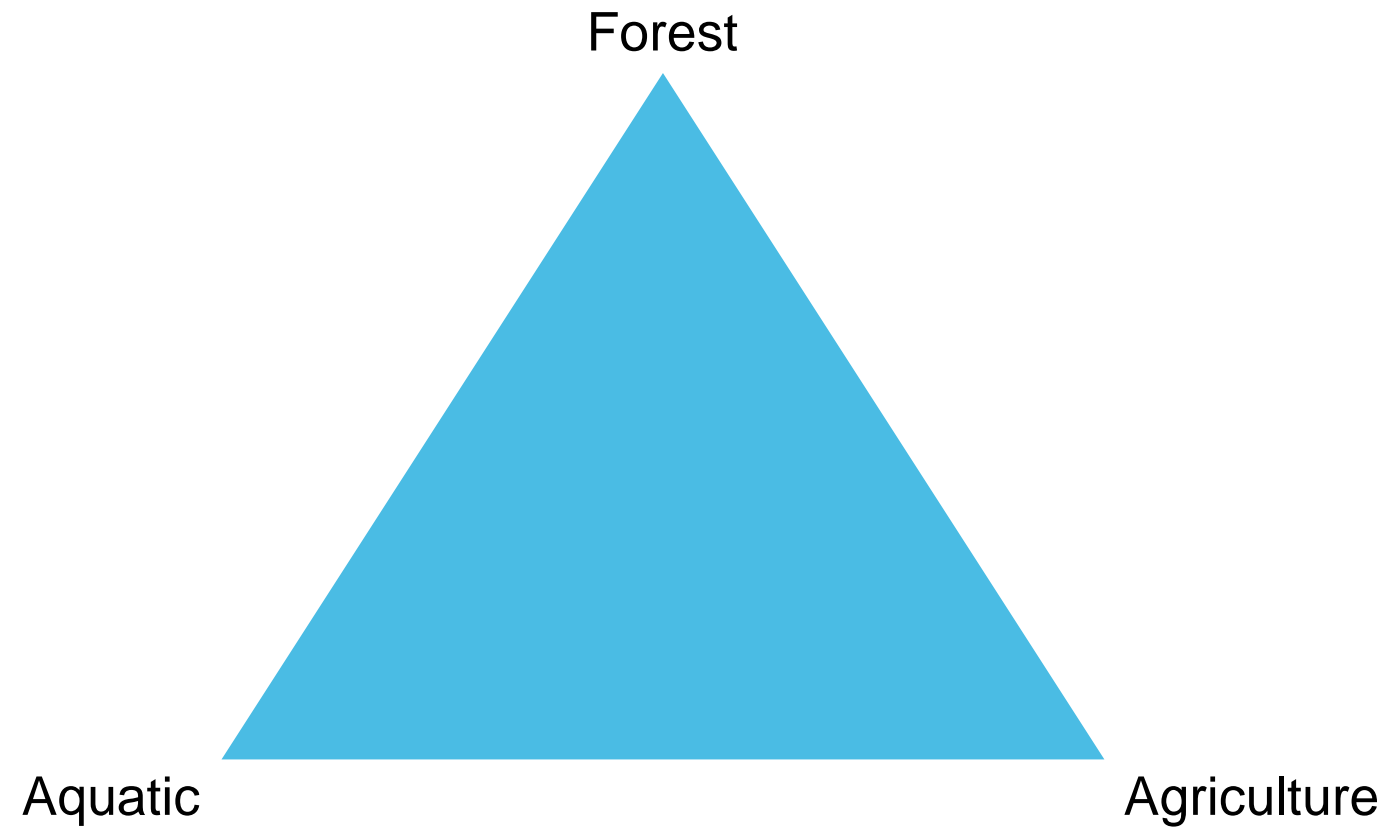


# Big picture: 40 TWh more electricity and 75 TWh (upgraded) biofuels is needed by 2045

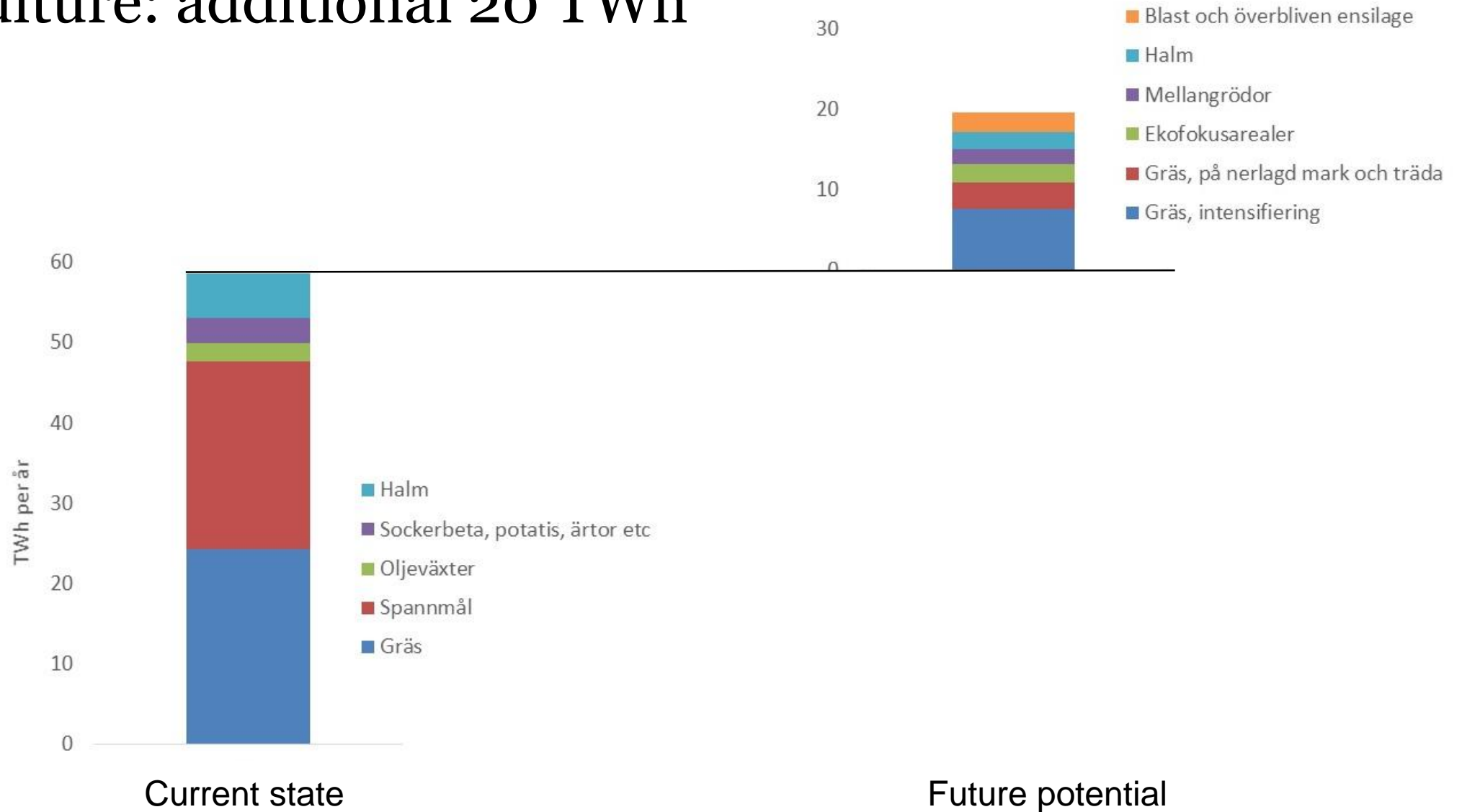
	Electricity	Biomass	solid	liquid	gas	Unspec.
SUMMARY	35-40	75	7-8	-20	11	37
Steel	17	4-5	1.5	-	3	-
Mining, metal and mineral	1-1.5	2-3	1.4	1.3	0.1	-
Chemistry, aluminium and refinery	1-1.5	8.4	0.4	-	8	-
Cement	0.3-0.5	4.5	4.5	-	-	-
Forest industry	0	2.5	-	-	-	2.5
Construction	-	0.5-1	-	-	-	0.5-1
Railroad	0.5-1	0	-	-	-	-
Road	16	34	-	-	-	34
Air travel, domestic	0	2	-	2	-	-
Air travel, international	0	10	-	10	-	-
Heavy duty machinery	0.5-1	6-6.5	-	6-6.5	-	-



# Possible sources for biomass



# Agriculture: additional 20 TWh



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# Aquatic biomass: additional 1 TWh

Biomass	Source	Today	2050 (TWh/a)
Macro alga	Harvest on beaches and coastal areas	0	0.4-0.8
Micro alga	WWT at pulp- and paper mills	0	0.1-0.3
	WWT at municipalities	0	0.1-0.4
SUMMARY		0	0.6-1.5

Reference: Presentation by Serina Ahlgren 2018, at IVA-seminar



# Forest

## Huge potential from complex system









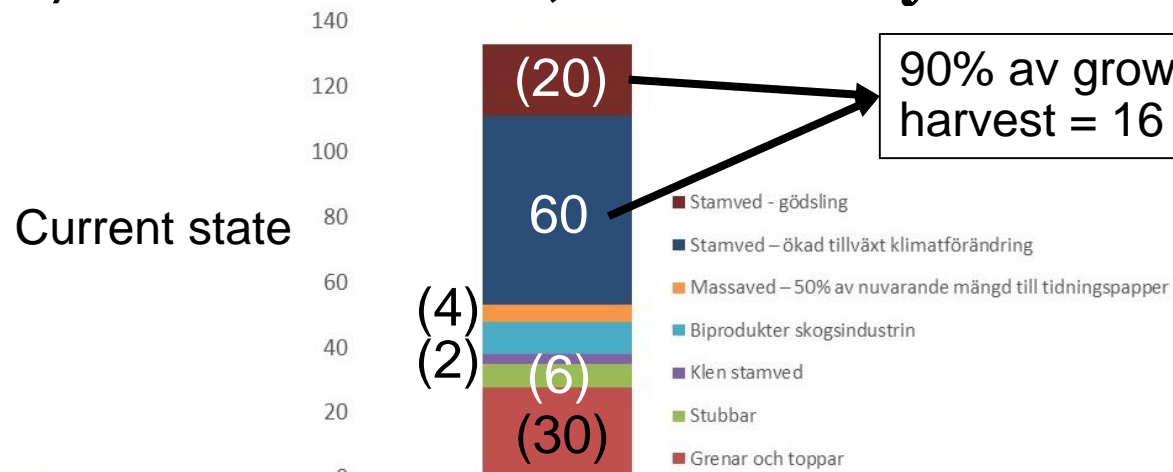
# Energy efficiency is the most important factor for lignin separation

		2019	2045	2019	2045
		0: Today	1: Increased prod.	2: Energy efficiency	Both 1 and 2
Market pulp production	Million Adt	3.7	4.7	3.7	4.7
Black liquor production	Million Adt	6.6	6.6	6.6	8.3
Heat demand	GJ/Adt	12.2	12.2	10.7	10.7
Power demand	kWh/Adt	750	750	600	600
Steam for power	GJ/Adt	3.9	3.9	3.1	3.1
Total steam demand	GJ/Adt	16.1	16.1	13.8	13.8
Equivalent black liquor	GJ/Adt	20.6	20.6	17.7	17.7
Black liquor	GJ/Adt	21.6	21.6	21.6	21.6
Spec. energy surplus	GJ/Adt	1	1	3.9	3.9
Energy surplus	TWh/a	1	1.3	4.0	5.1

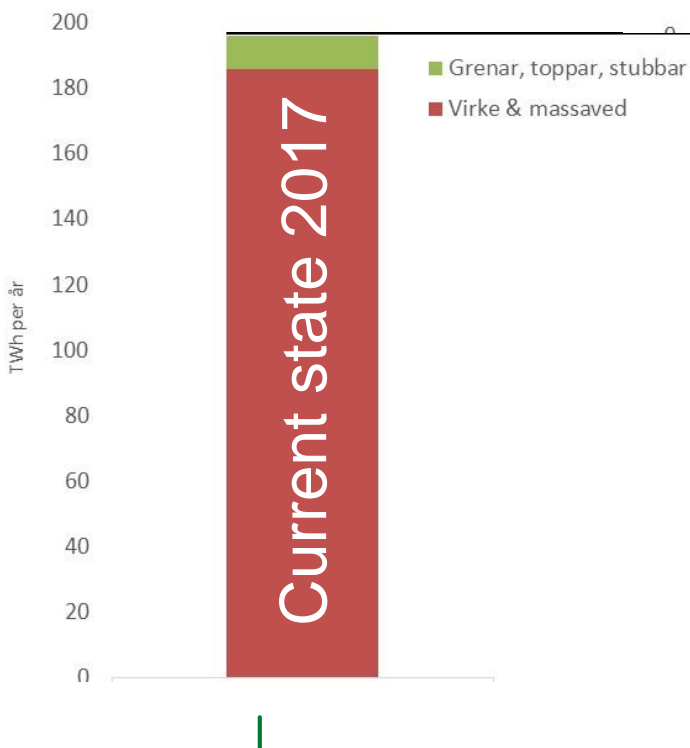
Data from typical swedish pulping industry, extracted from bransch lit. (Markarydsförlaget AB)



# Forest: 70 – 80 TWh, driven by roundwood to industry



90% av growth and 30% av harvest = 16 + 6 TWh



Fertilization*:	6
<b>Growth (SKA):</b>	<b>16</b>
Less Newsprint**:	1
Lignin:	5
Drying of byprod:	10
Thin stemwood:	2
Stubs:	6
<u>Br&amp;T***:</u>	<u>30</u>
<b>SUMMA:</b>	<b>76</b>

\* Not allowed in all areas today

\*\* Decreased production of Newsprint. Pulpwood is used in kraft pulping and gives energy products

\*\*\* Branches and Tops

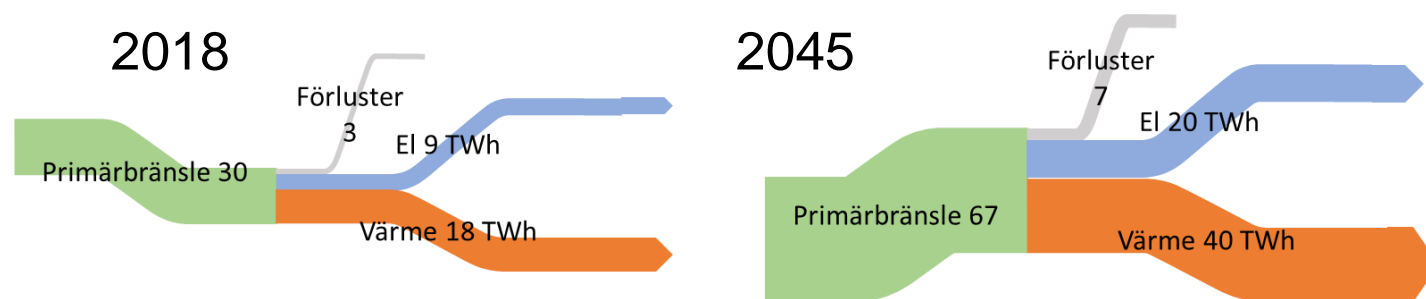


# 70 TWh more windpower 2045 and 37 TWh more biomass fuel

	Electricity
SUMMARY	<b>35-40</b>
Steel	17
Mining, metal and mineral	1-1.5
Chemistry, aluminium and refinery	1-1.5
Cement	0.3-0.5
Forest industry	0
Construction	-
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Railroad	0.5-1
Road	16
Air travel, domestic	0
Air travel, international	0
Heavy duty machinery	0.5-1

<u>Power production</u>	<u>2018:</u>	<u>2045</u>	
Water	65	68	
Wind	18	90	+70 TWh Wind
CHP*	9 (30)	20 (67)	+37 TWh biomass
Ind. CHP	6	3	
<u>Nuclear</u>	<u>63</u>	<u>0</u>	
Total	140	140 + <b>40</b>	

Data from energimyndighetens energi i siffror

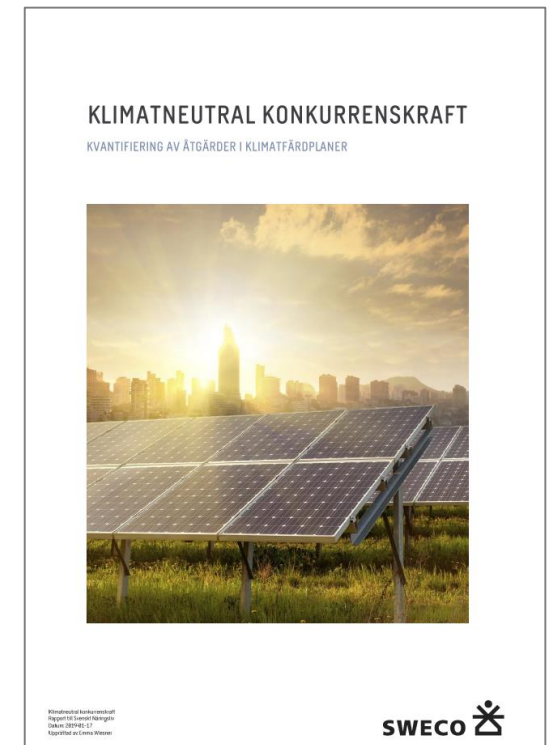


\*Assumed 30% electrical efficiency in CHP with wood chips and 50/50 volatile and storable power prod



# Big picture: 40 TWh more electricity and 75 TWh (upgraded) biofuels is needed by 2045

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Mining, metal and mineral	1-1.5	2-3	1.4	1.3	0.1	-
Chemistry, aluminium and refinery	1-1.5	8.4	0.4	-	8	-
Cement	0.3-0.5	4.5	4.5	-	-	-
Forest industry	0	2.5	-	-	-	2.5
Construction	-	0.5-1	-	-	-	0.5-1
Railroad	0.5-1	0	-	-	-	-
Road	16	34	-	-	-	34
Air travel, domestic	0	2	-	2	-	-
Air travel, international	0	10	-	10	-	-
Heavy duty machinery	0.5-1	6-6.5	-	6-6.5	-	-



# Total access $20 + 76 + 2 \approx 100$ TWh is much lower than expected demand of 200 TWh

	Total	Biochar	Liquid	Gas	Wood
SUMMARY (and yield)	75	7-8 (50%)	45 (45%)	20 (64%)	39-40 (100%)
As primary biomass	201.5	16	115+2.3	31	2.5 + 37
Steel	4-5	1.5		3	
Mining, metal and mineral	2-3	1.4	1.3	0.1	
Chemistry, aluminium and refinery	8.4	0.4		8	
Cement	4.5	4.5			
Forest industry	2.5				2.5
Construction	0.5-1		1		
Railroad	0				
Road	34		34		
Air travel, domestic	2		2		
Air travel, international	10		10		
Heavy duty machinery	6-6.5		6		



# Gasification of fuel for road transport reduces demand by around 40 TWh

	Total	Biochar	Liquid	Gas	Wood
SUMMARY (and yield*)	75	7-8 (50%)	45 (45%)	20 (64%)	39-40 (100%)
As primary biomass	163.5	16	40+2.3	70	2.5 + 35
Steel	4-5	1.5		3	
Mining, metal and mineral	2-3	1.4	1.3	0.1	
Chemistry, aluminium and refinery	8.4	0.4		8	
Cement	4.5	4.5			
Forest industry	2.5				2.5
Construction	0.5-1		1		
Railroad	0				
Road	34		0	34	
Air travel, domestic	2		2		
Air travel, international	10		10		
Heavy duty machinery	6		6		

Power	2018:	2045
Water	65	68
Wind	18	90
CHP*	9 (30)	20 (42 (65))
Ind. CHP	6	3
Nuclear	63	0
<b>Total</b>	<b>140</b>	<b>140 + 40</b>

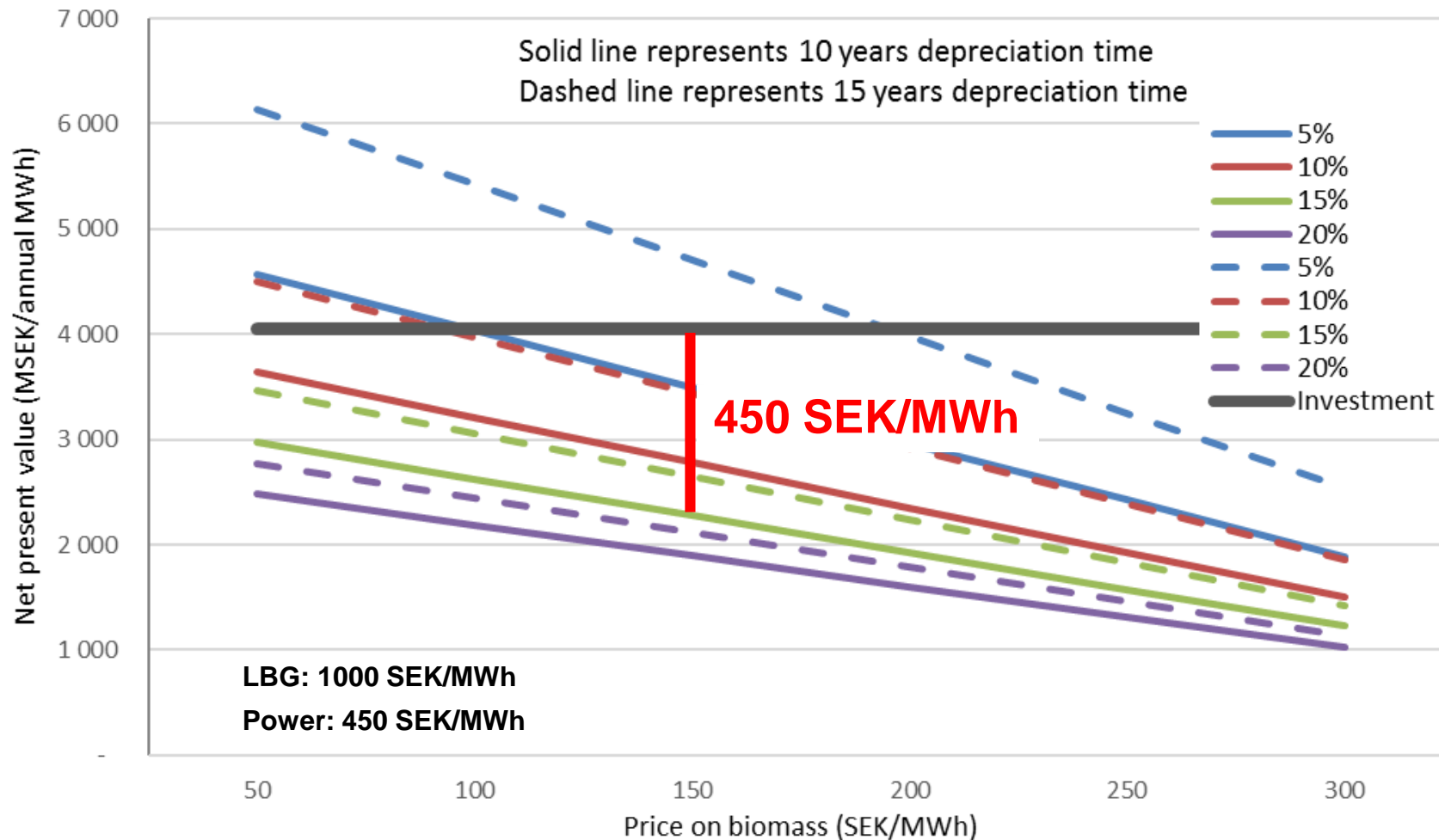
\*Assumed efficiency 95% (Ryaverket)  
Power:Heat (1:1)

\*Data from Skogsindustriernas report on biofuels

e.g. HTL from lignin since higher yield



# Business model is still not good enough



Large quantities of biomass is needed, gasification has a higher transformation efficiency. However, the challenge is that the business model is not good enough. Investment only profitable when calculating over 15 years and 5% interest rate.





# Summary

Opportunities within the forest industry:

Potential:

1. Low value solid biomass\* in the lime kilns in order to release liquid biooil, which will be needed in industry. 3 TWh
2. Using secondary heat for drying of saw dust and bark from industry which can be used in CHP. 10 TWh
3. Increase energy efficiency in stand-alone kraft pulp mills in order to separate lignin in proportional to the production of electricity. This could be used make transportation fuel (66% carbon in lignin vs 50% carbon in wood). 5 TWh
4. Gasification might contribute to reduce the need of biomass for production of transportation fuel, but business case needs to be strengthened 40 TWh

\*This often means bark, since sawdust can be upgraded to pellets, which will be needed in CHP

