Circular-economy market formation in the Danish construction industry

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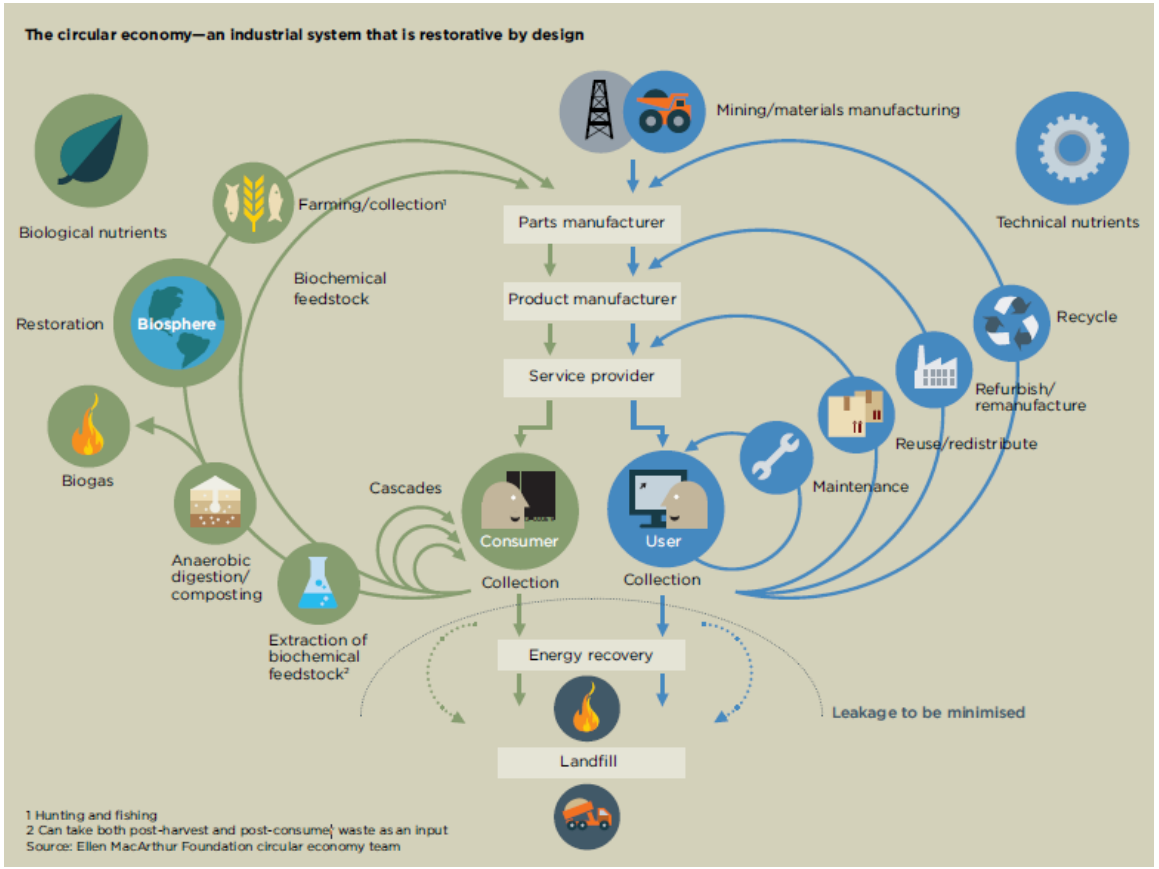
The circular economy



Constr/demo waste recycling Denmark, 2015

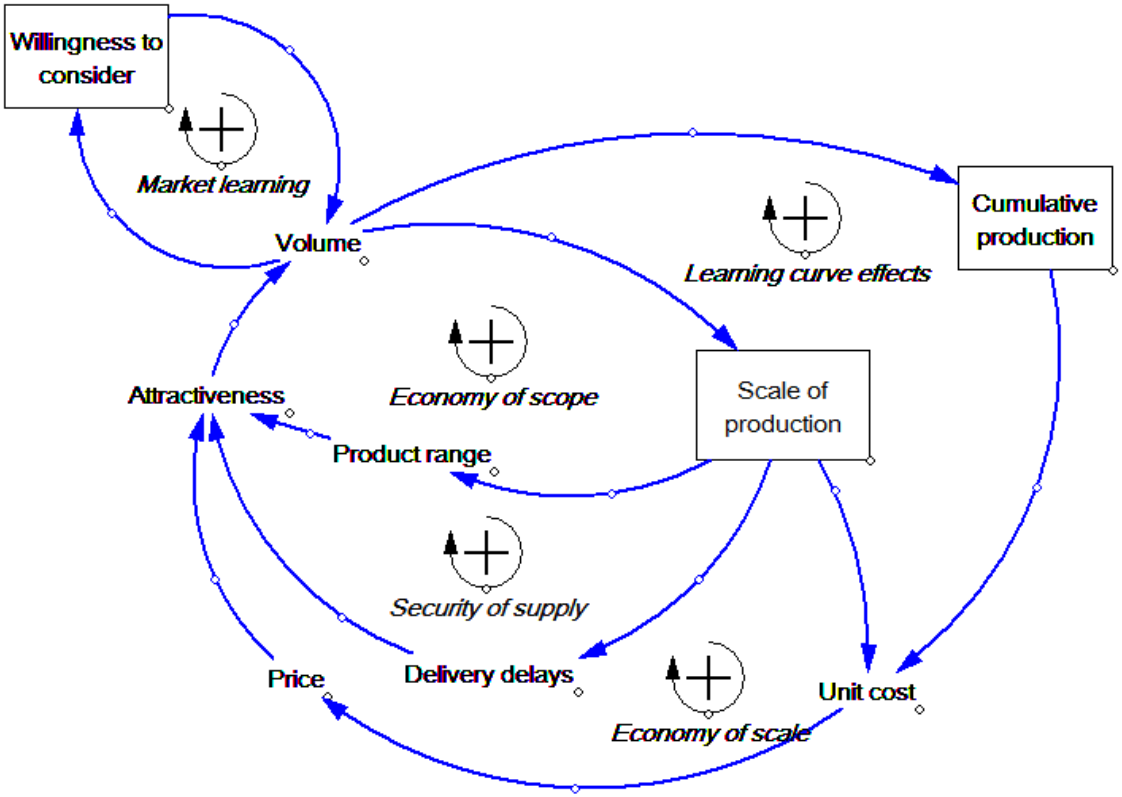
- ”Recycling”
- ”Re-use”
- ”Disposal”

Fraction	**Generation (1.000 t)**	**”Recycling” (%)**
Concrete wastes	1.061	90 %
Wood wastes	107	87 %
Tiles and ceramic wastes	77	87 %
C&D waste total	**4.162**	**87 %**

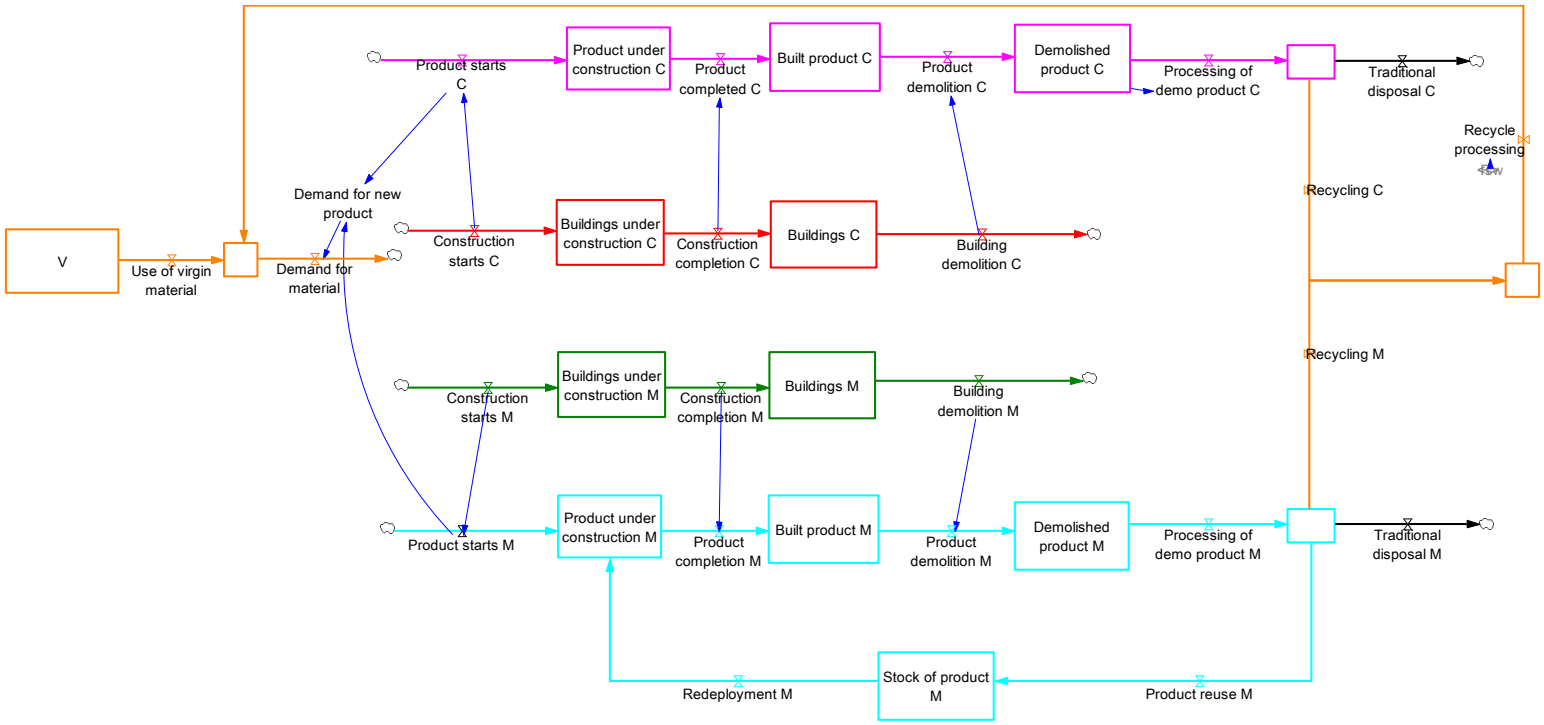
(Construction) waste market characteristics

- Waste as a “high-entropy” product (messy)
- Quality and consistency
- Misalignment of ownership and capabilities
- Market learning
- Scale and scope economies
- Geography and natural monopolies
- Timing and management attention

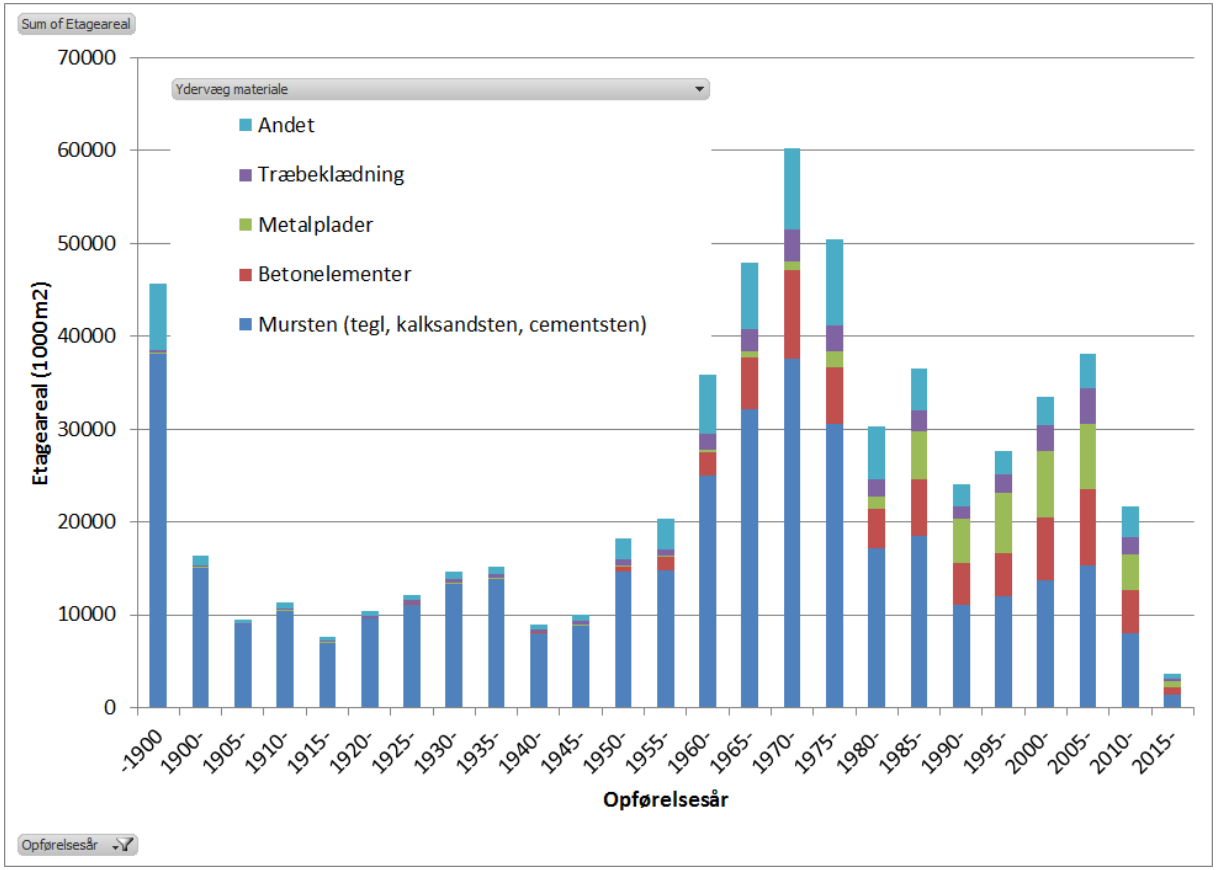
Market dynamics



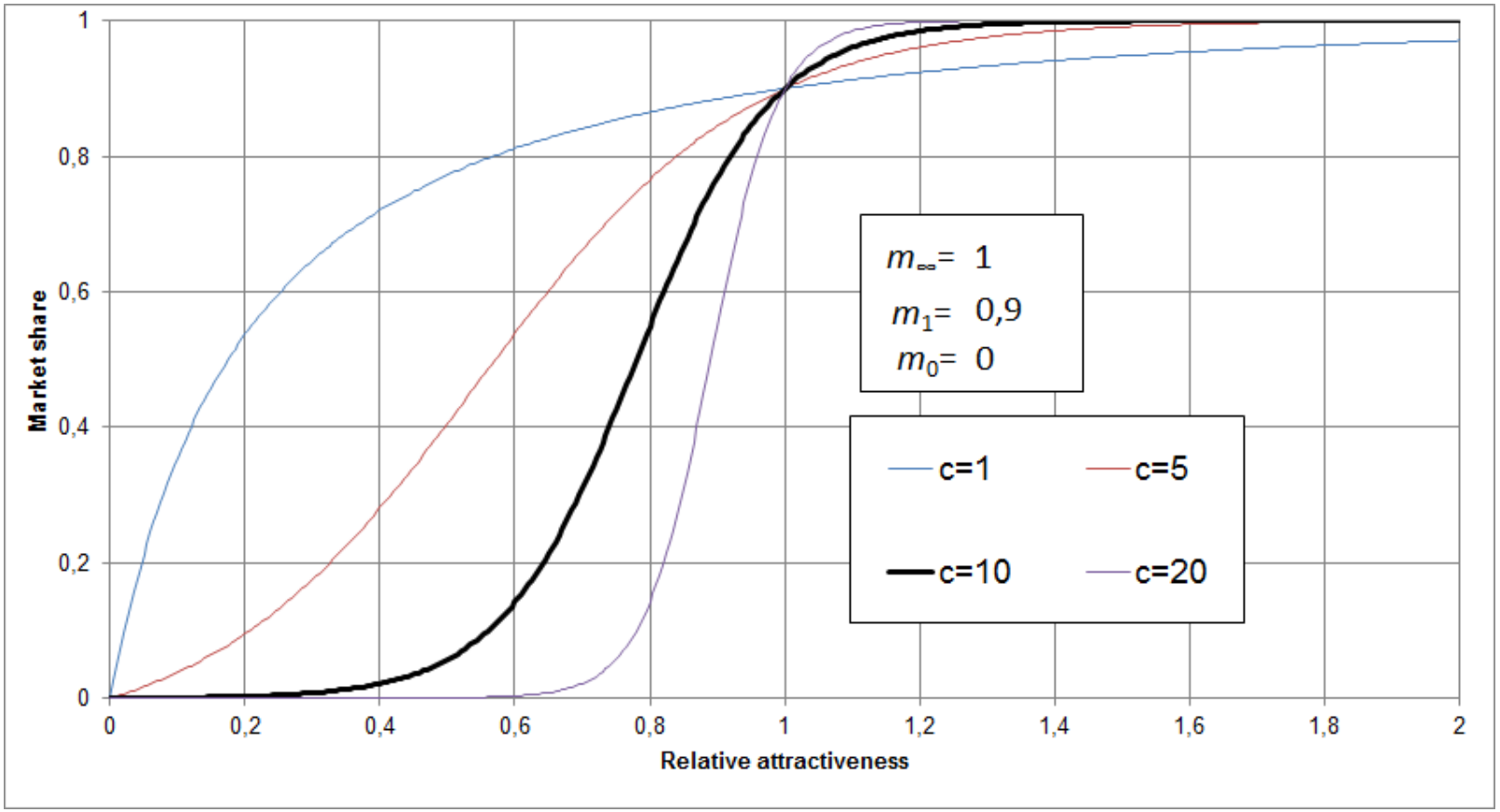
Material flows, concrete



Material mix over the years



Demand: product attractiveness



$$A = W \left(\frac{P}{P_A}\right)^{\pi} \left(\frac{Q}{Q_A}\right)^{\theta} \left(\frac{K}{K_A}\right)^{\rho},$$

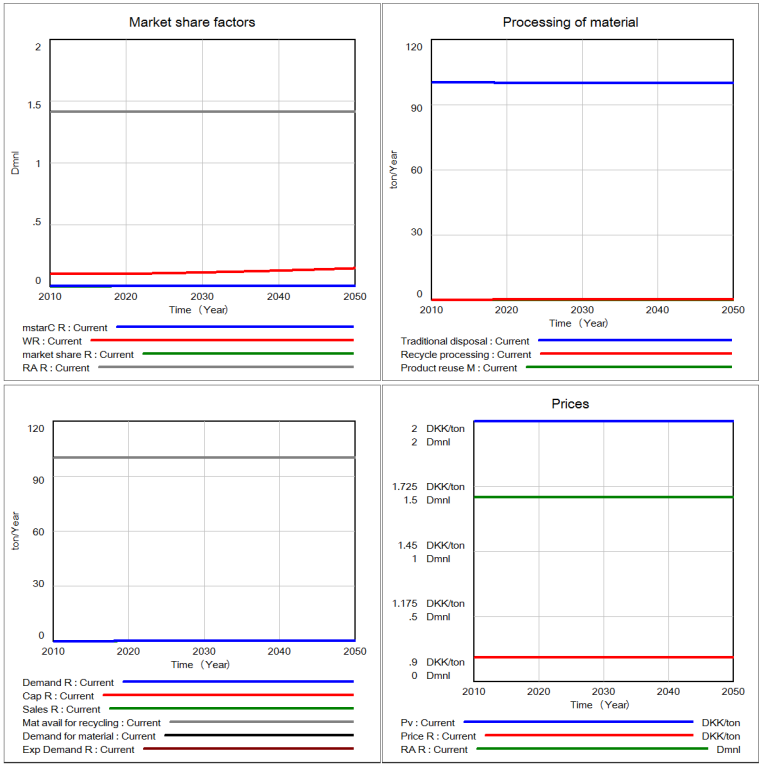
WtC Price Quality Scope

Supply

- Constrained by capacity (production, distribution, marketing, administration, etc.)
- Sales (demand) constrained by stocks available (except concrete RA sector)
- Quantity signals: recent sales (and needs for stock replinishments) → desired capacity → investments in capacity
- Price signals: Shortages → margins → investments in capacity
- Potential shortage of virgin material could drive up price, supporting recycle market

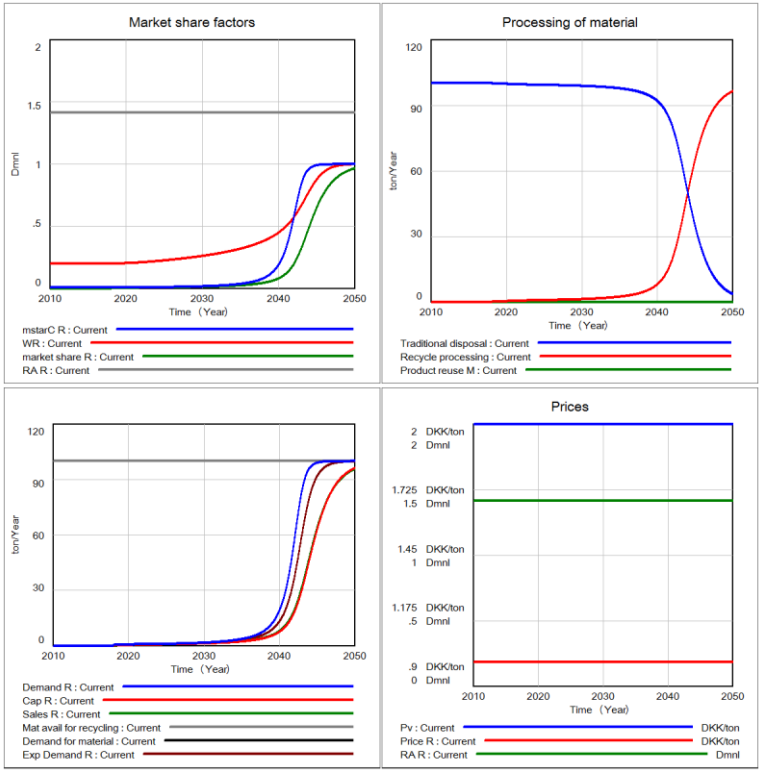
Tipping point dynamics from market awareness

Recycled material attractive (PV = 2)



WtC=10%

Figure 3

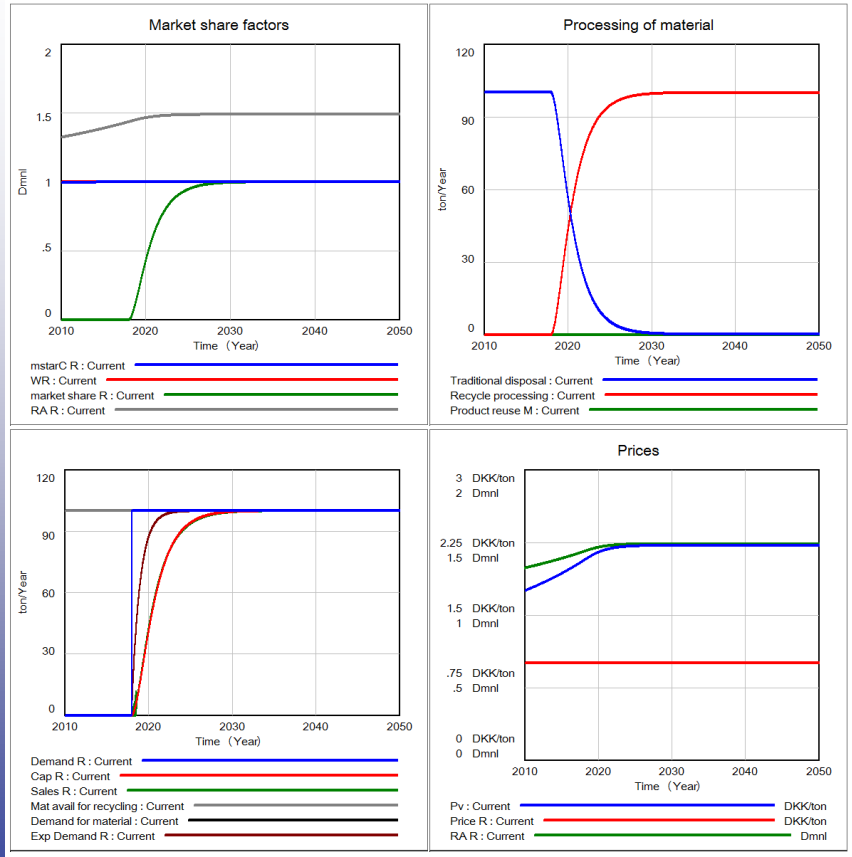


WtC=20%

Figure 4

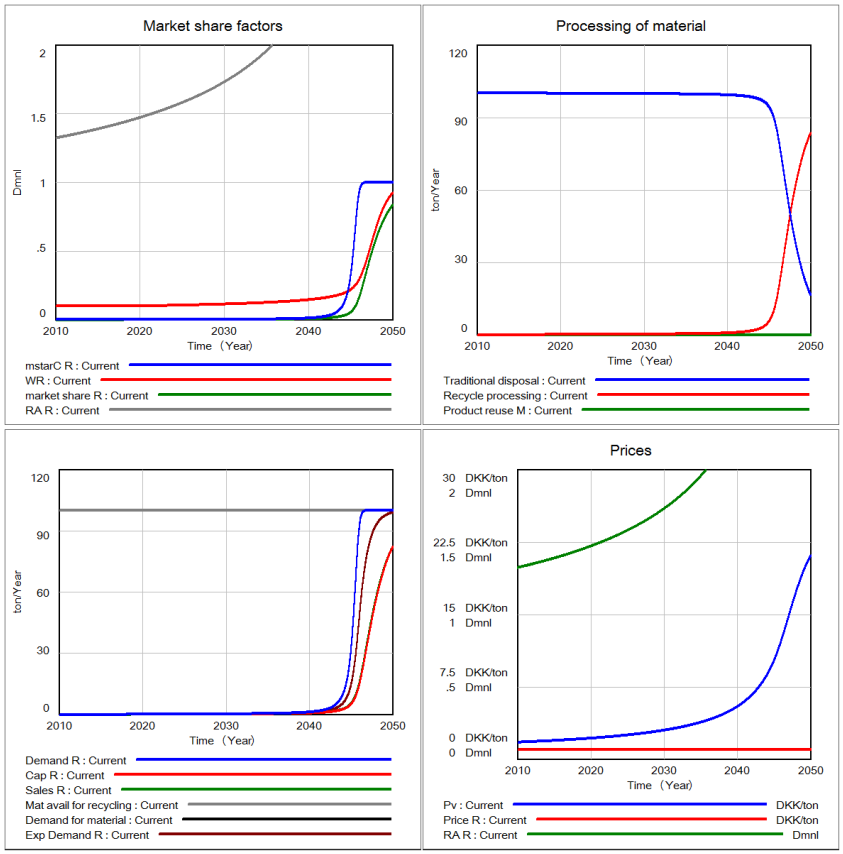
Market learning as a barrier to scarcity signal

Scarcity of virgin material activated (rho=1)



Ideal market (initial WtC=100%)

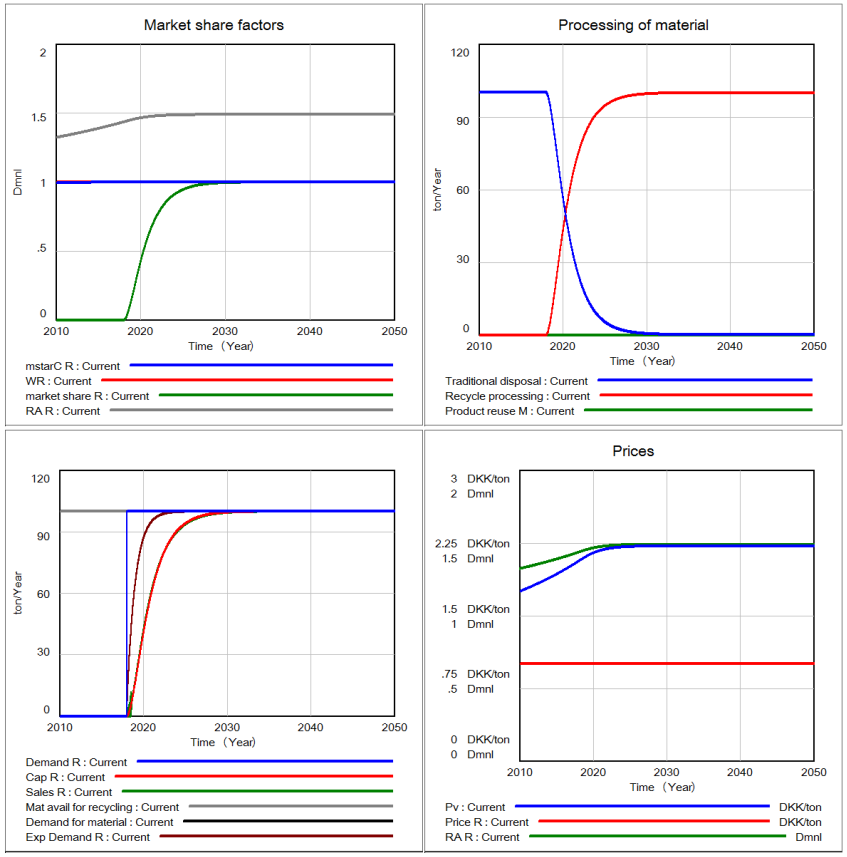
Figure 5



Market learning (initial WtC=10%)

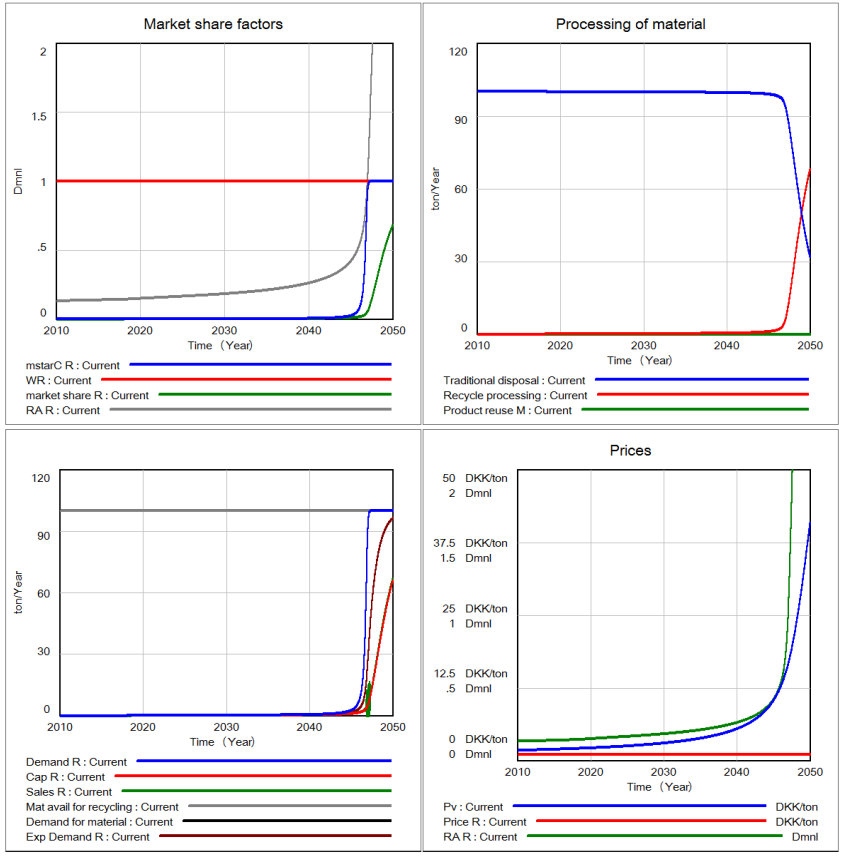
Figure 6

Scope economy as barrier



Ideal market (initial WtC=100%)

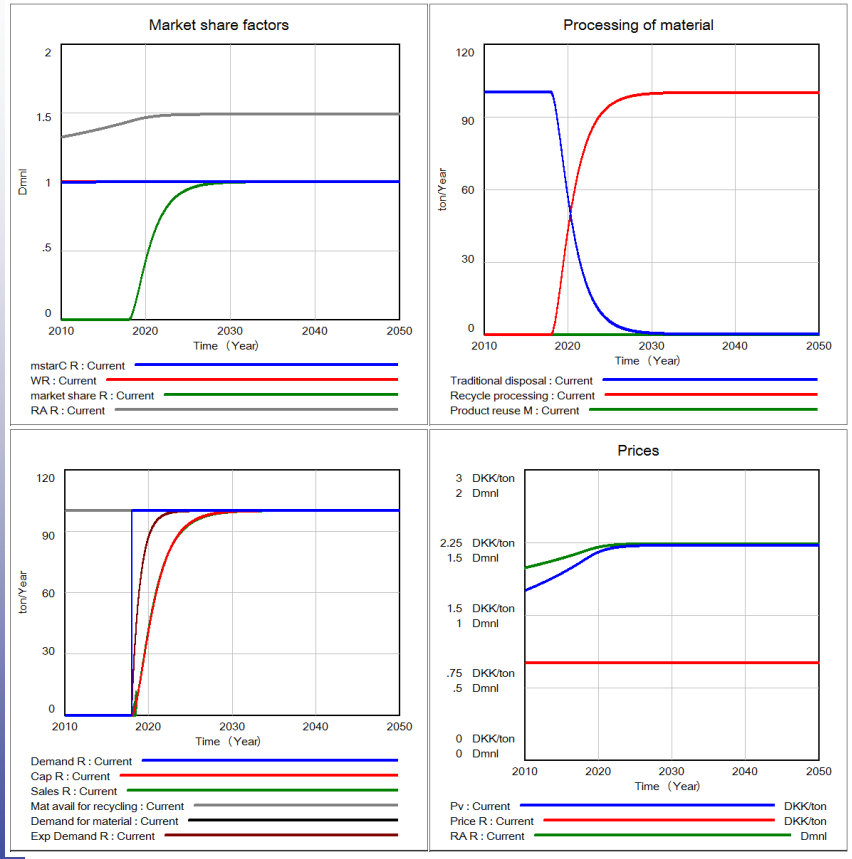
Figure 5



Scope economy barrier (initial beta=0,25)

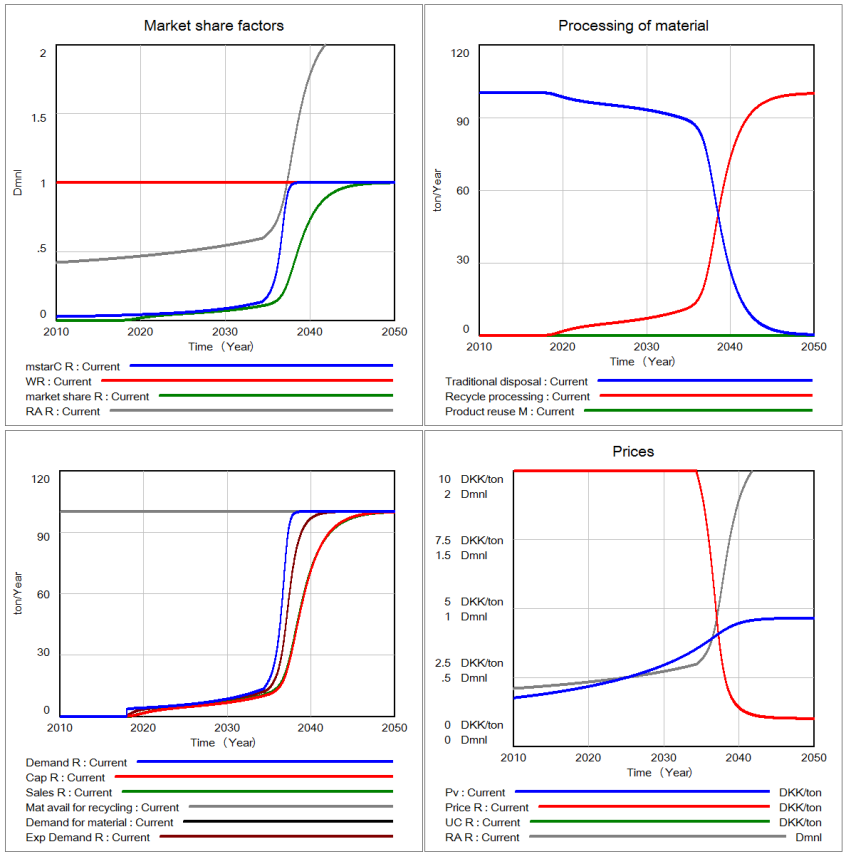
Figure 7

Scale economy as barrier



Ideal market (initial WtC=100%)

Figure 5



Scale economy barrier (initial alpha=1)

Figure 8

Implementing policy initiatives

Parameter	#1: Certification	#2: Trading platform	#3: Value demonstration	#4: GPP
h: marketing effect on WtC	+	+	+	
κ strength of word-of-mouth	+	+	+	
Q quality	+			
ν required inventory coverage		-		
Reference unit cost		-		
Reference scope capacity		-		
Autonomous demand component				+

Policy 1: Certification, seems to work…

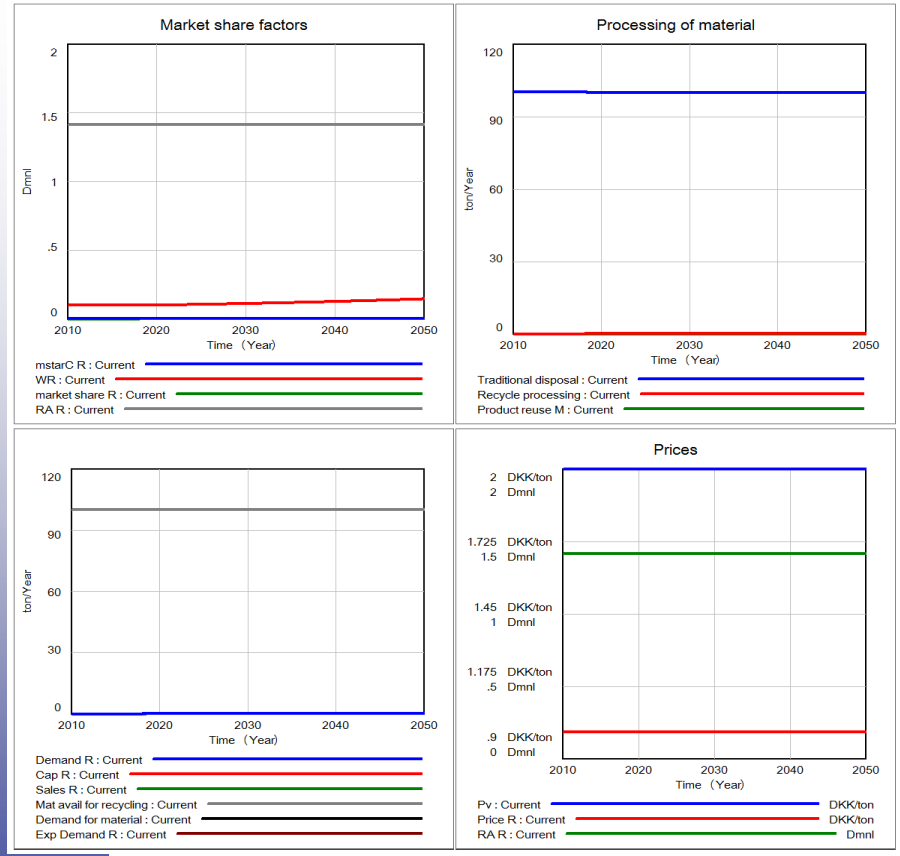


Figure 3

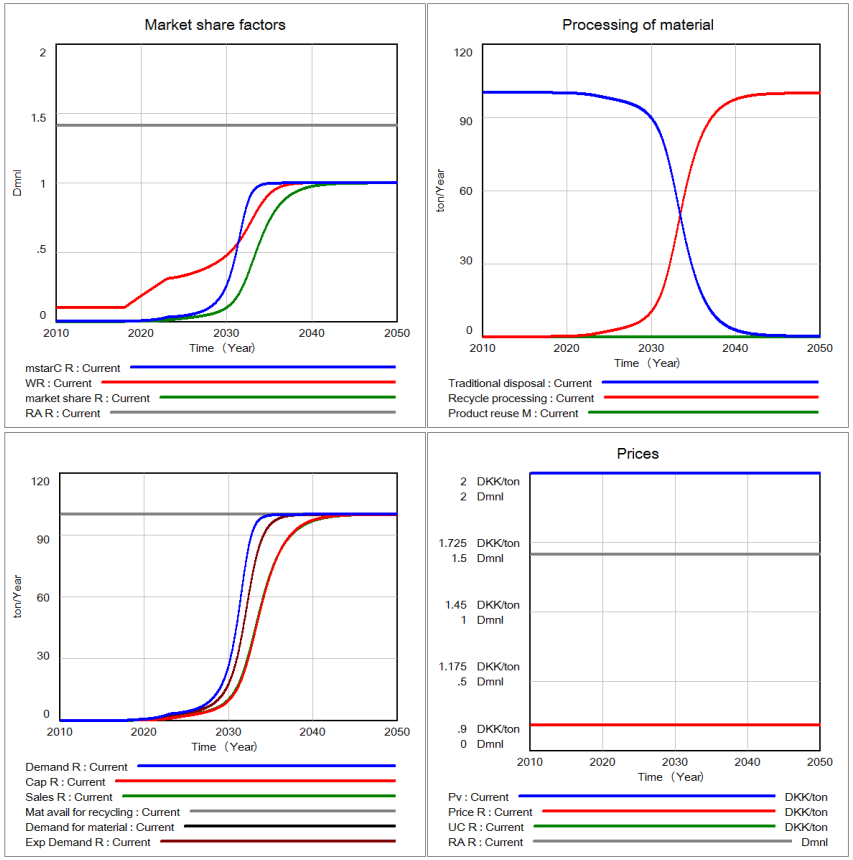
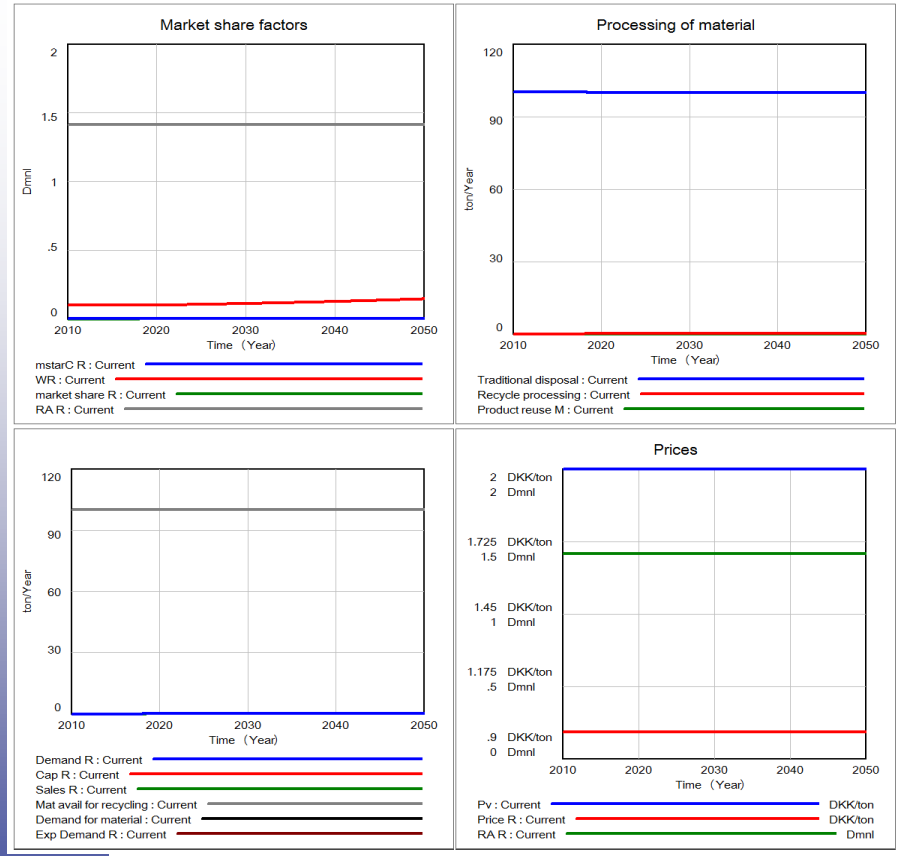


Figure 9

… but not if, e.g., scope effects are active



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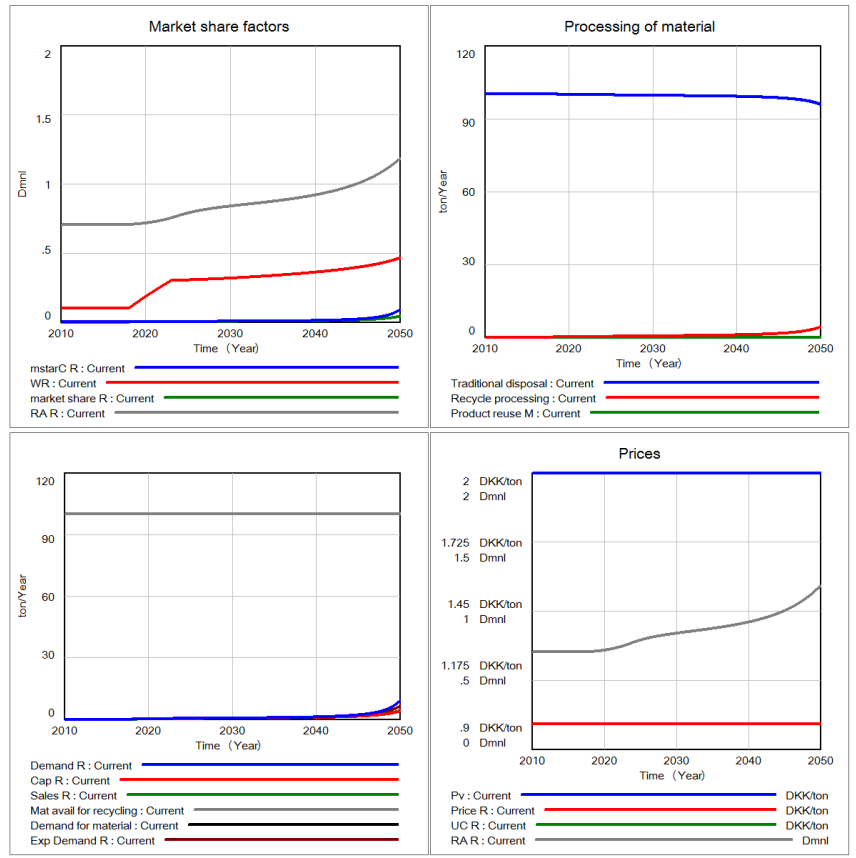
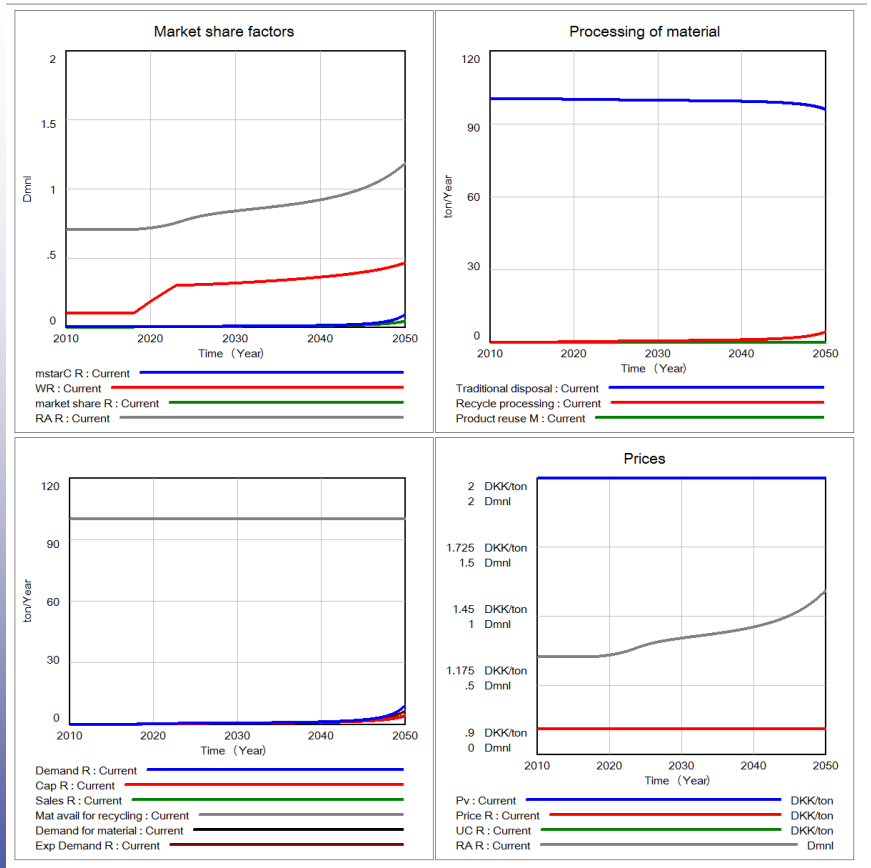


Figure 10

Policy 2: Trading platform (reduces scope barrier)



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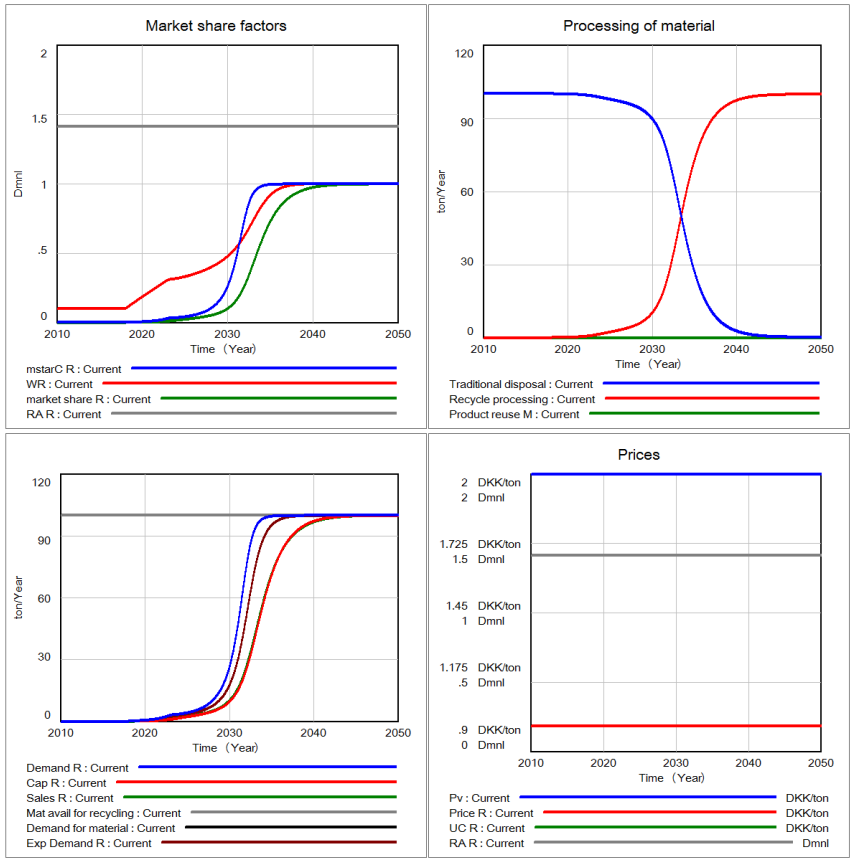
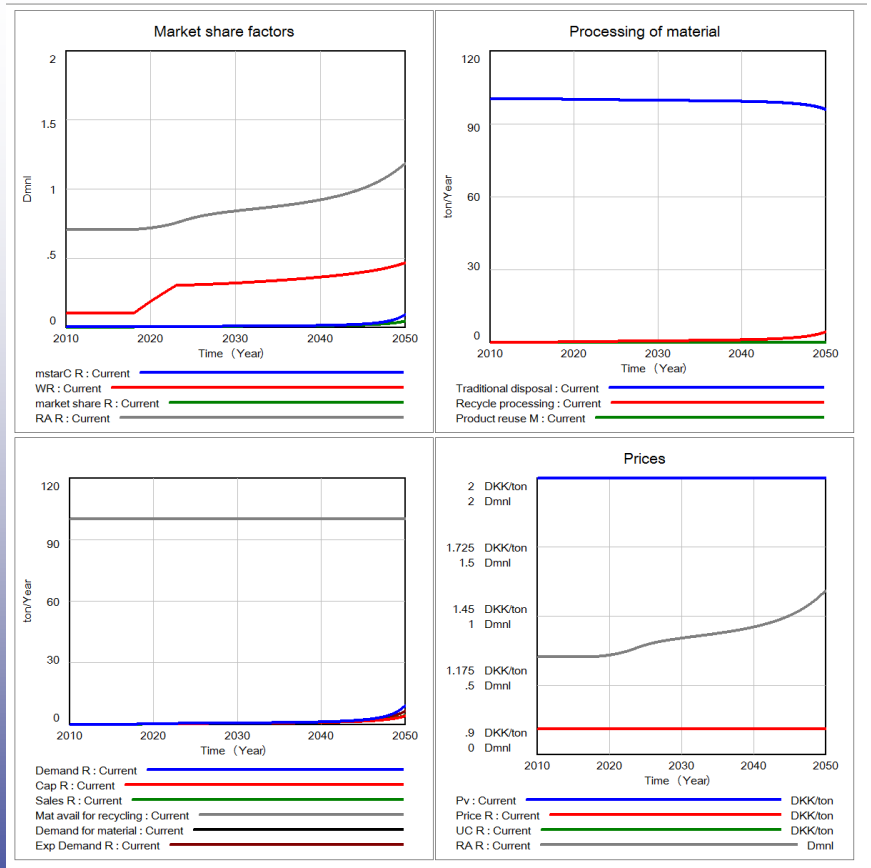


Figure 12

Policy 4: GPP (drives transition)



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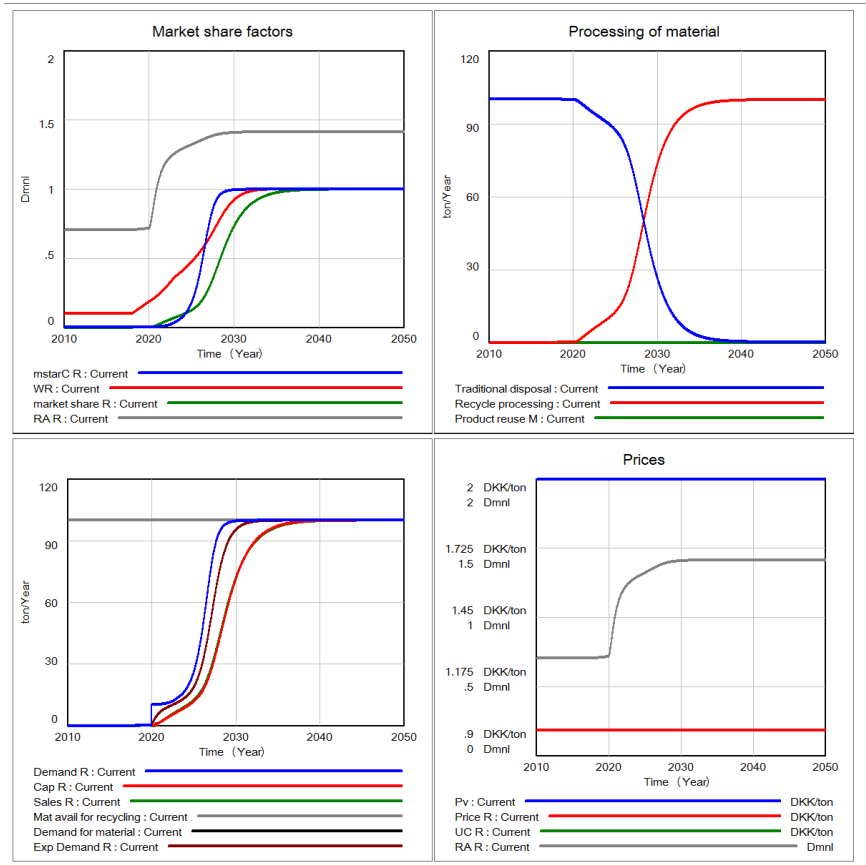

Figure 13

Policy conclusions

- All four policies can have positive effects, but they are likely to all have to be used in combination to effect transition.
- Initiatives operate on different leverage points in the system
- Demo projects, certification and trading all improve information to buyers and thus mitigate risks.
- In case of concrete RA market, this is enough to effect transition, but may not be in the other markets
- Market matching improves scope economies and quality which can accelerate development, but results are sensitive to assumptions
- GPP is a robust and effective way of boosting transition
- TRANSITION TAKES TIME!!! Due to inertial factors in the system