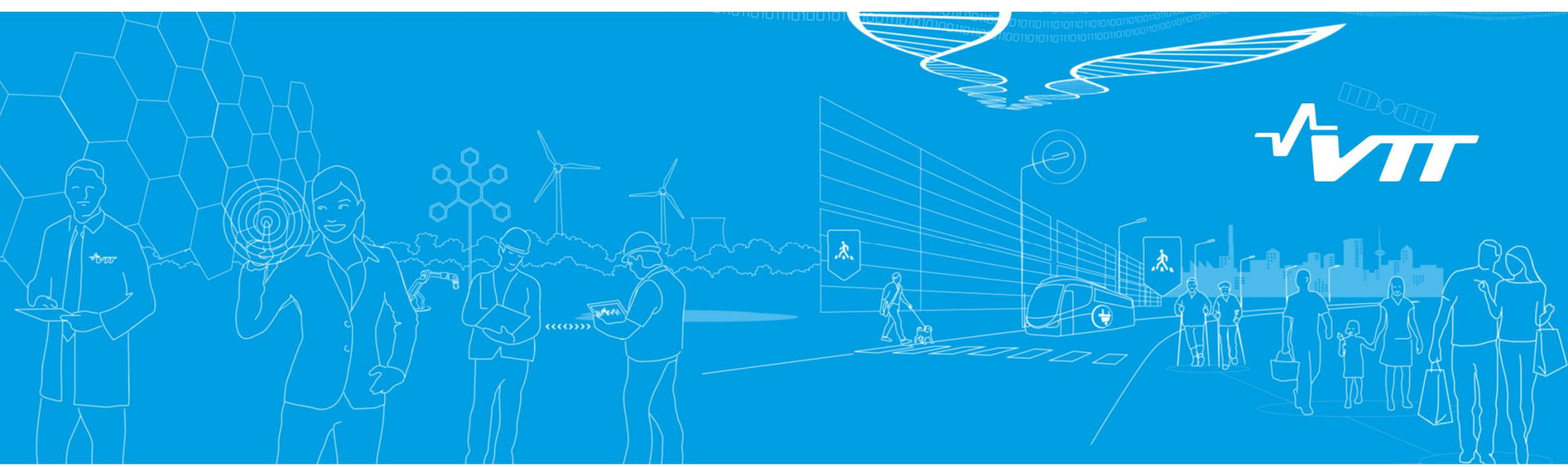

Optimal forest rotation with increasing carbon pricing

IEA Task 38, 9.12.2014

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Forests and carbon pricing

- Forest in the carbon cycle:
  growth → sink, combustion or decay → emission

- Carbon flows could be priced to achieve economic efficiency

Past research on the impact of carbon pricing on forestry:

- Forest-owner's perspective:
  - van Kooten et al., 1995
  - Hoen and Solberg, 1997
  - Pohjola and Valsta, 2007

Constant carbon price P_c

- As a part of the macroeconomy:
  - Tahvonen, 1995
  - Sohngen and Mendelsohn, 2003
  - Lintunen and Uusivuori, 2014

Economically efficient mitigation

- Numerical mitigation scenarios:
  increasing carbon price, often exponentially

- Ekholm, 2014: price evolution for meeting 2°C cost-efficiently

Current marginal cost

Future marginal cost

Impact of emissions to the 2°C target

$$c'_t(r_t) = \beta E_t \left[c'_{t+1,s}(r_{t+1,s}) \frac{\sum_{\tau=t+1}^{\infty} \left(I_s(t,\tau) \beta^{\tau-t-1} \lambda_{\tau,s} \right)}{\sum_{\tau=t+2}^{\infty} \left(I_s(t+1,\tau) \beta^{\tau-t-1} \lambda_{\tau,s} \right)} \right]$$

Discount factor

(Climatic Change 127, pp. 153-167, dx.doi.org/10.1007/s10584-014-1243-8)

The forest-owner's problem

- Maximize the revenues by choosing the timing of fellings

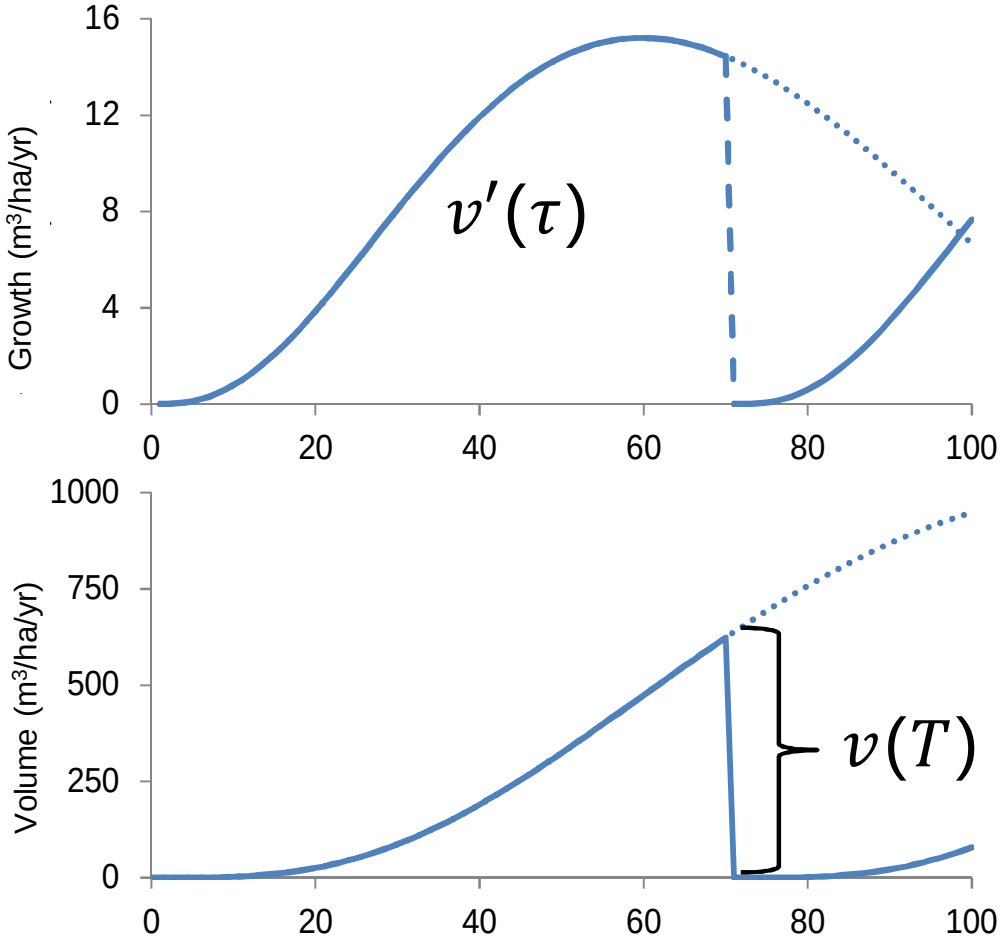
  → When to cut: the optimal forest rotation length T?

- Things to consider:
  - Forest growth rate – the forest growth curve $v\ (t)$ (m^3/ha)
  - Price of timber P_f ($/m^3)
  - Price of carbon P_c ($/tC) and its annual growth rate ρ
  - Discount rate r
  - Regeneration costs C ($/ha)

- But: carbon price changes over time

  → the optimal rotation lengths $T_1, T_2, \ldots$ differ

Optimal rotation with increasing carbon pricing



Income from forest growth:

$$\int_0^T \alpha P_c \, e^{\tau(\rho-r)} v'(\tau) d\tau$$

Carbon content per volume

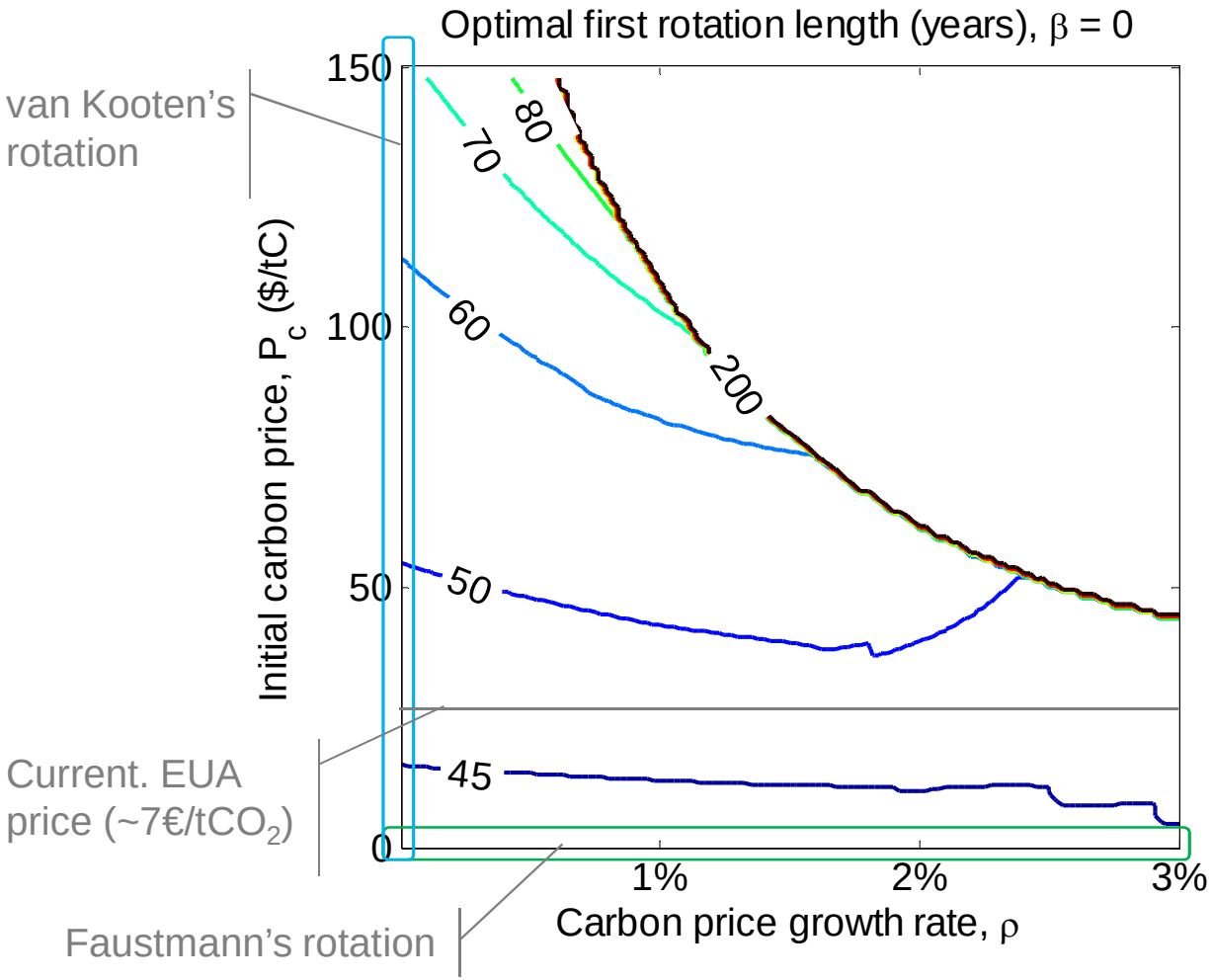
Net income from fellings:

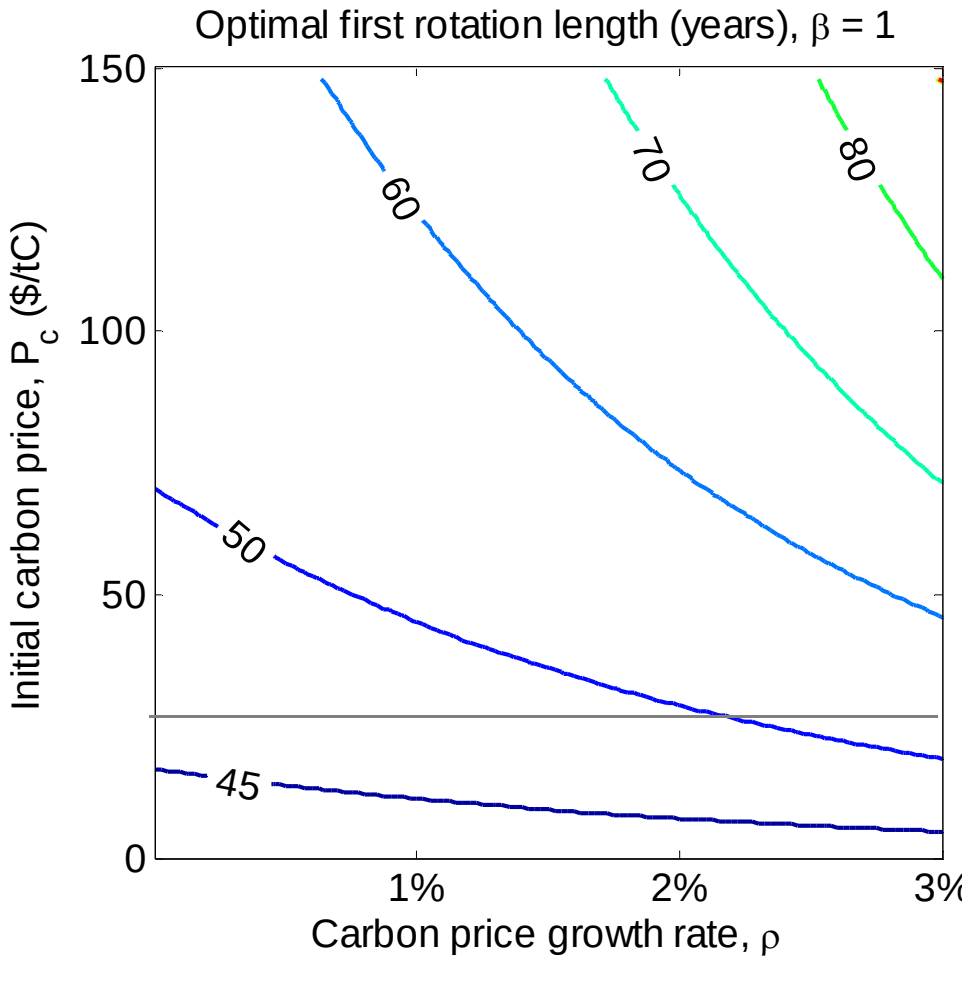
$$e^{-rT}\left[(P_f - \alpha(1-\beta)e^{\rho T} P_c)\, v(T) - C\right]$$

Share of carbon that is stored permanently

Optimal length for the first rotation

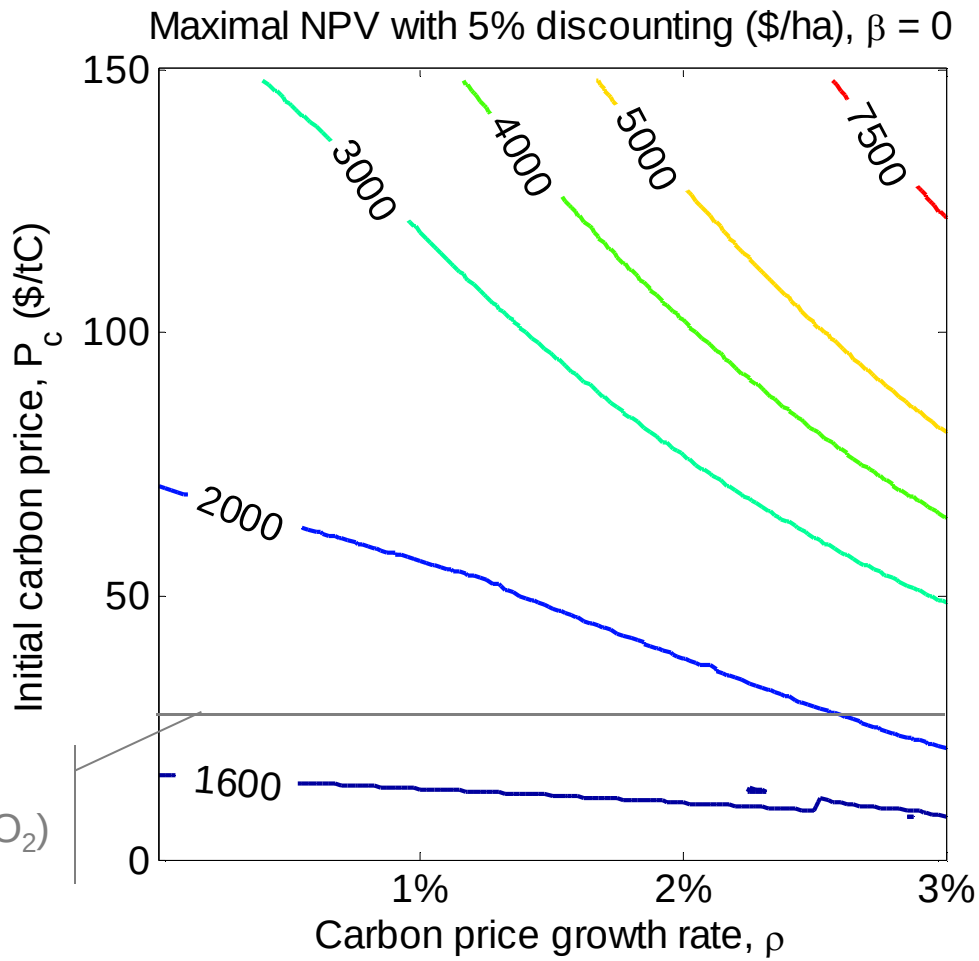
Discount rate: 5%, timber price = 50 $/m^3, growth curve: van Kooten et al. (1995)



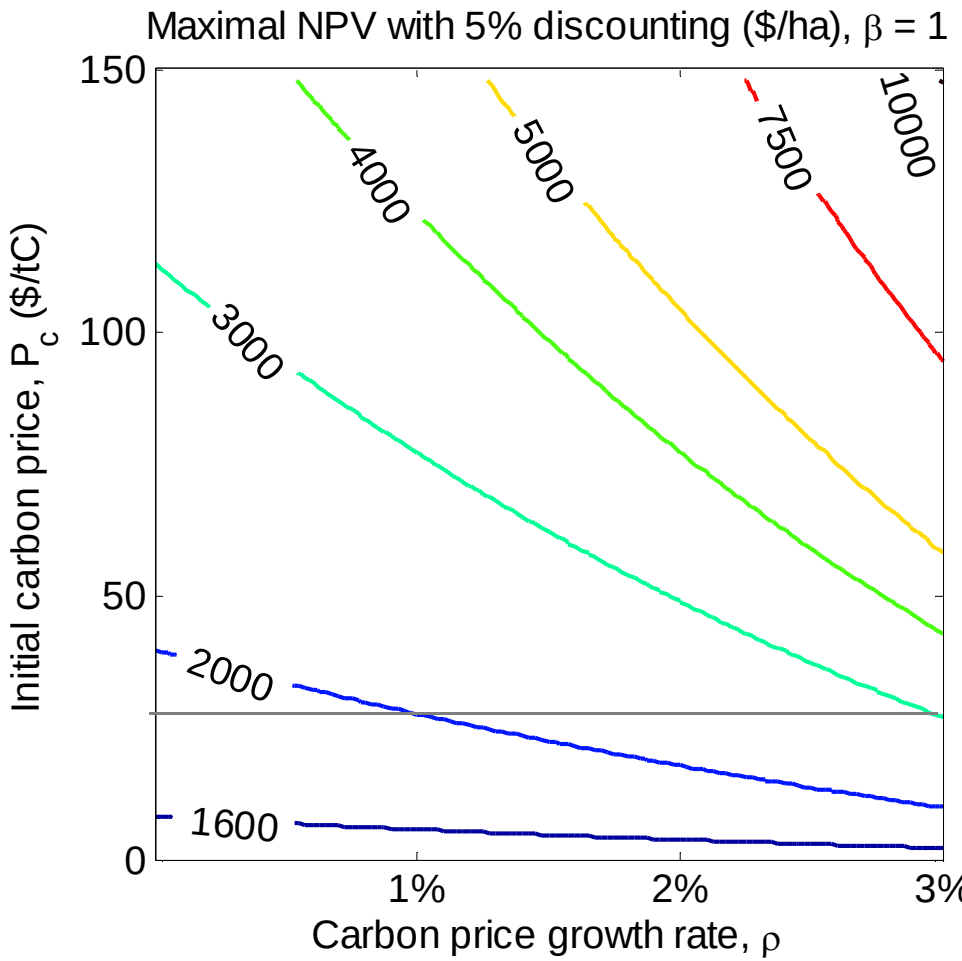


Bare land value ($/ha)

Discount rate: 5%, timber price = 50 $/m³, growth curve: van Kooten et al. (1995)



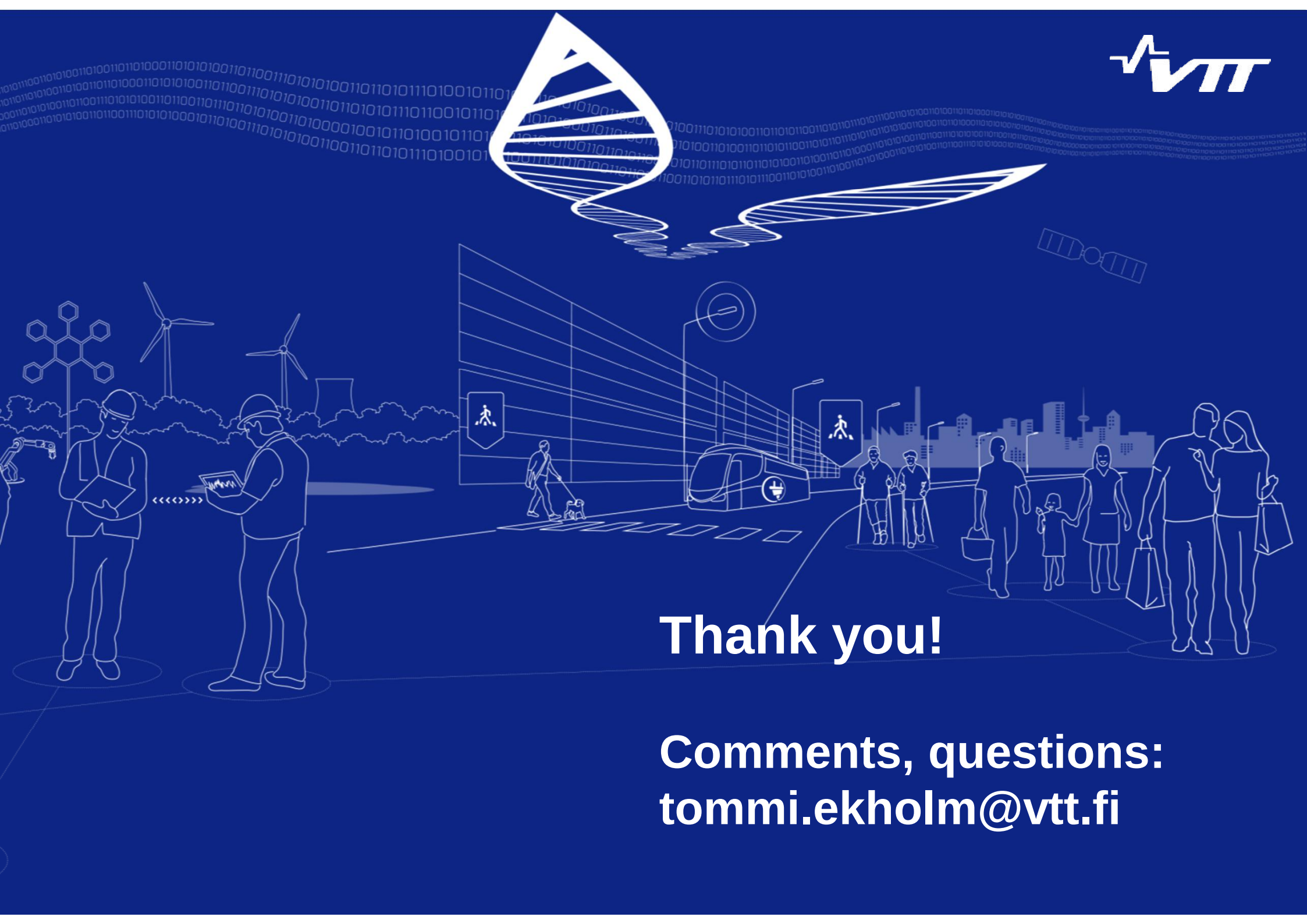
Current. EUA price (~7€/tCO$_2$)



Final remarks

- P_c and ρ both increase rotation lengths and land value
- If carbon is released to the atmosphere ($\beta = 0$), the optimal rotation might be lengthened to “infinity”

- A number of important aspects not considered here:
  - Increasing price for timber
  - Forest management, e.g. thinnings
  - Risks of forest fires etc. damages
  - Uncertainty, particularly for carbon pricing



Thank you!

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