S6: Equations

Equations for Driver 2

1. Urban agriculture

$$UA_{min/\max\,(ha)}\ **= Y_{\min/\max UA} \times (F_{\mathrm{prod(ha)}} + Veg_{prod(ha)})$$

** Possible reduced area due to Urban agriculture approaches

2. Vertical farming

$$VF_{min/\max\,(ha)}\ *** = \frac{Veg_{prod\left(\frac{Mg}{a}\right)}}{Y_{min/maxVF}}$$

*** Possible production of whole German vegetable production in Vertical farming production systems

3. Abandoned areas reduction due to usage

$$Ma_{usable(ha)} = Ab_{\min/\max\,(ha)} - (UA_{min/\max\,(ha)} + VF_{min/\max\,(ha)})$$

Equations for Driver 4

4. Algae

$$ALG_{summin\,/\max\left(\frac{Mg}{a}\right)} = ALG_{(ha)} \times Y_{\min/\max ALG(dm)}$$

Equations for Driver 5

5. Short rotation coppice on agricultural areas (maximum/minimum)

$$SRCAG_{\min\,(ha)Year_{aim}} = \frac{(SRCAG_{\min(ha)2050} - SRCAG_{\min(ha)2020})}{(Year_{End} - Year_{Stat})} \times (Year_{Aim} - Year_{Stat})$$

$$SRCAG_{min\,/\max\left(\frac{Mg}{a}\right)} = SRC_{min/maxAG(ha)} \times Y_{min/maxSRC(dm)}$$

6. Short rotation coppice on marginal areas

$$SRCMA_{min/max\left(\frac{Mg}{a}\right)} = Ma_{usable(ha)} \times Y_{min/maxSRC(dm)}$$

7. Short rotation coppices on currently used areas for energy plants

$$SRCCU_{\max\left(\frac{Mg}{a}\right)} = CU_{\max(ha)} \times Y_{min/maxSRC(dm)}$$

8. Miscanthus on marginal areas

$$MSCMA_{min\,/\,\max\left(\frac{Mg}{a}\right)} = Ma_{usable(ha)} \times Y_{\min/\max MSC(dm)}$$

9. Miscanthus on currently used areas for energy plants

$$MSCCU_{min/\,\max\left(\frac{Mg}{a}\right)} = CU_{\max(ha)} \times Y_{min/maxSRC(dm)}$$

Equations for Driver 6

10. Paludiculture potentials

$$PAL_{summax\left(\frac{Mg}{a}\right)} = PAL_{\max(ha)} \times Y_{\min/\max PAL(dm)}$$

Equations for Driver 15

11. Sum of lignocellulosic materials suitable for PLA production (LIGP)

$$LIGP_{summin\left(\frac{Mg}{a}\right)} = QLIG_{mobi(dm)} + SRCAG_{\min\left(\frac{Mg}{a}\right)} + SRCMA_{min\left(\frac{Mg}{a}\right)} + SRCCU_{\min\left(\frac{Mg}{a}\right)} + MSCMA_{\min\left(\frac{Mg}{a}\right)} + MSCCU_{\min\left(\frac{Mg}{a}\right)} + PAL_{summax\left(\frac{Mg}{a}\right)}$$

$$LIGP_{summax\left(\frac{Mg}{a}\right)} = QLIG_{tech(dm)} + SRCAG_{\max\left(\frac{Mg}{a}\right)} + SRCMA_{max\left(\frac{Mg}{a}\right)} + SRCCU_{\max\left(\frac{Mg}{a}\right)} + MSCMA_{\max\left(\frac{Mg}{a}\right)} + MSCCU_{\max\left(\frac{Mg}{a}\right)} + PAL_{summax\left(\frac{Mg}{a}\right)}$$

12. PLA of food waste (PLAQFW)

$$PLAQFW_{\max\left(\frac{Mg}{a}\right)} = \left(\left(QFW_{tech}{}_{\max\left(\frac{Mg}{a}\right)} \times FOP\right) \times PLA_{LAC}\right)$$

$$PLAQFW_{\min\left(\frac{Mg}{a}\right)} = \left(\left(QFW_{mobi}{}_{\min\left(\frac{Mg}{a}\right)} \times FOP\right) \times PLA_{LAC}\right)$$

13. Share of plastic production of PLA from food waste material in comparison to national and international scale (PLAQFWS)

$$PLAQFWS_{GER}{}_{\min/\max\left(\frac{Mg}{a}\right)} = \left(\frac{PLAF_{\min/\max\left(\frac{Mg}{a}\right)}}{POLD_{GER}}\right) \times 100$$

$$PLAQFWS_{EU}{}_{\min/\max\left(\frac{Mg}{a}\right)} = \left(\frac{PLAF_{\min/\max\left(\frac{Mg}{a}\right)}}{POLD_{EU}}\right) \times 100$$

$$PLAQFWS_{EU}{}_{\min/\max\left(\frac{Mg}{a}\right)} = \left(\frac{PLAF_{\min/\max\left(\frac{Mg}{a}\right)}}{POLP_{EU}}\right) \times 100$$

$$PLAQFWS_{World}{}_{\min/\max\left(\frac{Mg}{a}\right)} = \left(\frac{PLAF_{\min/\max\left(\frac{Mg}{a}\right)}}{POLP_{World}}\right) \times 100$$

14. PLA of Lignocellulosic material (PLALIG)

$$PLALIG_{\min/\max\left(\frac{Mg}{a}\right)} = \left(LIGP_{summin/max\left(\frac{Mg}{a}\right)} \times LACA_{LIG_{min/max}}\right) \times PLA_{LACA_{min/max}}$$

15. Share of plastic production of PLA from lignocellulosic material in comparison to national and international scale (PLALIGS)

$$PLALIGS_{GER}{}_{\min/\max\left(\frac{Mg}{a}\right)} = \left(\frac{PLALIG_{\min/\max\left(\frac{Mg}{a}\right)}}{POLD_{GER}}\right) \times 100$$

$$PLALIGS_{EU}{}_{\min/\max\left(\frac{Mg}{a}\right)} = \left(\frac{PLALIG_{\min/\max\left(\frac{Mg}{a}\right)}}{POLD_{EU}}\right) \times 100$$

$$PLALIGS_{EU}{}_{\min/\max\left(\frac{Mg}{a}\right)} = \left(\frac{PLALIG_{\min/\max\left(\frac{Mg}{a}\right)}}{POLP_{EU}}\right) \times 100$$

$$PLALIGS_{World}{}_{\min/\max\left(\frac{Mg}{a}\right)} = \left(\frac{PLALIG_{\min/\max\left(\frac{Mg}{a}\right)}}{POLP_{World}}\right) \times 100$$

Equations for Driver 16

16. Sum of lignocellulosic materials suitable for ethanol production (LIGE)

$$LIGE_{summin\left(\frac{Mg}{a}\right)} = QBRETH_{min(dm)} + SRCAG_{\min\left(\frac{Mg}{a}\right)} + SRCMA_{min\left(\frac{Mg}{a}\right)} + SRCCU_{\min\left(\frac{Mg}{a}\right)} + MSCMA_{\min\left(\frac{Mg}{a}\right)} + MSCCU_{\min\left(\frac{Mg}{a}\right)} + PAL_{summax\left(\frac{Mg}{a}\right)}$$

$$LIGE_{summax\left(\frac{Mg}{a}\right)} = QBRETH_{max(dm)} + SRCAG_{\max\left(\frac{Mg}{a}\right)} + SRCMA_{max\left(\frac{Mg}{a}\right)} + SRCCU_{\max\left(\frac{Mg}{a}\right)} + MSCMA_{\max\left(\frac{Mg}{a}\right)} + MSCCU_{\max\left(\frac{Mg}{a}\right)} + PAL_{summax\left(\frac{Mg}{a}\right)}$$

17. Biodiesel production from algae biomass

$$BIODI_{AlG\ \min/\max\left(\frac{Mg}{a}\right)} = \left(ALG_{summin/max\left(\frac{Mg}{a}\right)} \times LIP_{ALG\,min/max}\right) \times LIP_{FAME}$$

18. Share of biodiesel production of biodiesel from algae biomass (BIODIALG)

$$BIODIALG_{GER}{}_{\min/\max\left(\frac{Mg}{a}\right)} = \left(\frac{BIODI_{Alg\ \min/\max\left(\frac{Mg}{a}\right)}}{BIODI_{GERcons}}\right) \times 100$$

19. Ethanol production from suitable lignocellulosic materials (ETHLIG)

$$ETHLIG_{\min\left(\frac{Mg}{a}\right)} = \left(LIGE_{summin/max\left(\frac{Mg}{a}\right)} \times Y_{ETH\,\text{minbeech}}\right) \times ETH_{conv}$$

$$ETHLIG_{\max\left(\frac{Mg}{a}\right)} = \left(LIGE_{summin/max\left(\frac{Mg}{a}\right)} \times Y_{ETH\,\text{maxwheat}}\right) \times ETH_{conv}$$

20. Share of ethanol production of lignocellulosic material in comparison to national and international consumption scale (ETHLIGS)

$$ETHLIGS_{GER}{}_{\min/\max\left(\frac{Mg}{a}\right)} = \left(\frac{ETHLIG_{\max\left(\frac{Mg}{a}\right)}}{ETHP_{Ger}}\right) \times 100$$

$$ETHLIGS_{EU}{}_{\min/\max\left(\frac{Mg}{a}\right)} = \left(\frac{PLALIG_{\min/\max\left(\frac{Mg}{a}\right)}}{ETHP_{EU}}\right) \times 100$$

$$ETHLIGS_{EU}{}_{\min/\max\left(\frac{Mg}{a}\right)} = \left(\frac{PLALIG_{\min/\max\left(\frac{Mg}{a}\right)}}{ETHP_{World}}\right) \times 100$$

Equations for Driver 18

21. Land consumption according to animals

$$\sum FoDAN_{(di;ca;pi;po2016)(ha)} = \left(\left(FC_{di;ca;pi;po2016}\right) \div 100\right) \times \quad FoD_{2017(ha)}$$

22. Reduced land consumption due to 25 % reduction of diary and meat products

$$\sum RLaC_{(di;ca;pi;porr25)(ha)} = FoDAN_{(di;ca;pi;po2016)(ha)} \times \left(\left(100 - AN_{di;ca;pi;porr25}\right) \div 100\right)$$

23. Reduced land consumption due reduced meat consumption of 30 kghead per years

$$\sum RLaC_{(di;ca;pi;porr30k)(ha)} = FoDAN_{(di;ca;pi;po2016)(ha)} \times \left(\left(100 - AN_{di;ca;pi;porr25}\right) \div 100\right)$$

24. Land gaining through 25% reduction of diary and meat products

$$ARG_{rr25} = \sum FoDAN_{(di;ca;pi;po2016)(ha)} - \sum RLaC_{(di;ca;pi;porr25)(ha)}$$

25. Land gaining through reduced meat consumption of 30 kghead per years

$$ARG_{rr30k} = \sum FoDAN_{(di;ca;pi;po2016)(ha)} - \sum RLaC_{(di;ca;pi;porr30k)(ha)}$$