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ShortFor: WP4

Life Cycle Assessment of the Greenhouse Gas Balance of Irish Short Rotation Forestry

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December 11th, 2017

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An Roinn Talmhaíochta, Bia agus Mara

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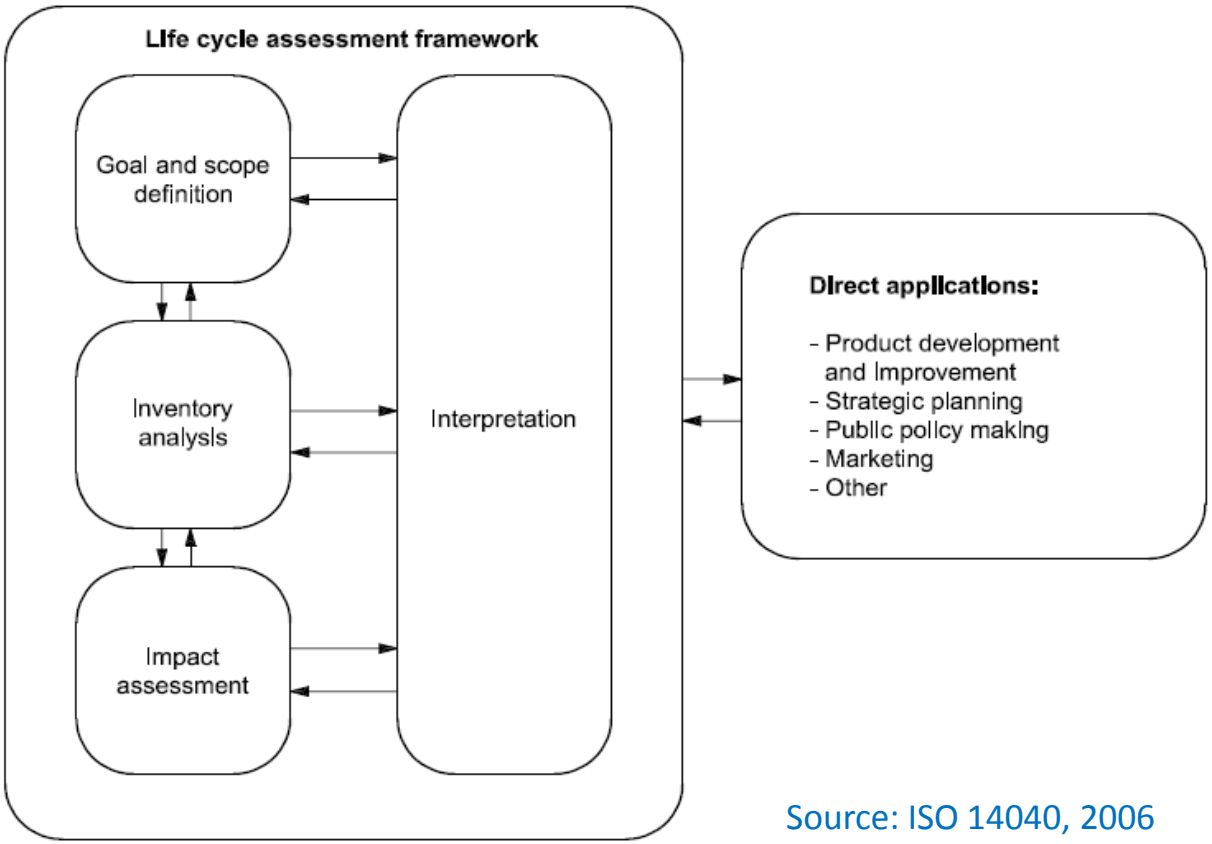
Introduction

Short Rotation Forestry (SRF) as specified in the DAFM 2014-2020 “Forestry for Fibre” Grant and Premium Categories:

- **In this study SRF is confined to single stem tree species suitable to Irish climate and soil conditions.**
- **Plantations managed over rotations of 10-20 years.**
- **Minimum planting density of 2,500 stems ha^{-1}.**
- **Potential Irish SRF genera: Eucalyptus, Italian Alder, and Poplar clones.**

LCA: Materials and Methods

- LCA is a method of comparing products and services using the framework below to identify environmental impacts attributable to resource consumption, emissions and wastes (Pennington *et al*, 2004).
- LCA is usually conducted via specialised software tools (OpenLCA) and databases (EcoInvent).



Source: ISO 14040, 2006

LCA: Goal and Scope

- Goal:
  - Measure the greenhouse-gas (GHG) balance of SRF biomass for bioenergy, by examining the material and energy inputs and outputs within a defined system boundary.
- Scope:
  - **SRF:** Eucalyptus nitens biomass (stem, wholetree, stump) over a sequence of 3 × 10 year rotations.
  - **Reference system:** Biomass for bioenergy from Sitka spruce (SS) forestry, i.e., pulpwood from thinnings and clearfell, forest residues, and stumps, in a 30 year rotation.
  - **LCA system boundary:** Cradle-to-grave (nursery to ash disposal).
  - **The "functional unit":** Quantitative measure of the functions that the product provides, i.e., 1 MWh of energy.

LCA: Materials & Methods

- **LCA software tools**: OpenLCA v 1.5, MS Excel.
- **LCA data:** Ecoinvent v.3.2, literature on Irish and international forest bioenergy LCA's.
- The following biomass assortments were used in modelling the LCA scenarios:

1. SRF stem-only
2. SRF whole-tree
3. SRF whole-tree + stump
4. SRF whole-tree + stump + N, P, K fertilizer
5. SS clearfell pulpwood
6. SS clearfell pulpwood, brash + stump
7. SS thinning + clearfell pulpwood
8. SS thinning + clearfell pulpwood, brash + stump, + N, P, K fertilizer

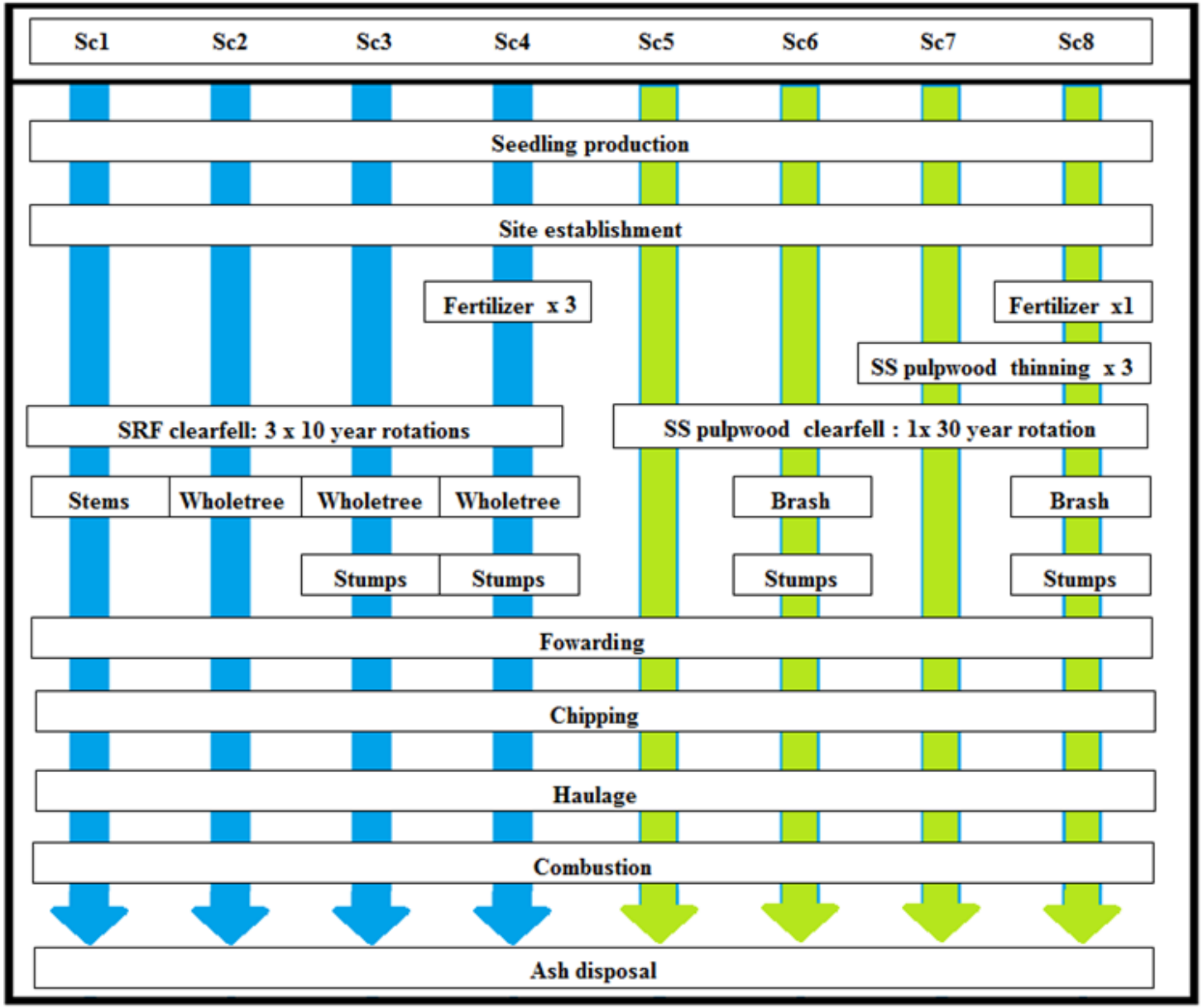
LCA: Assumptions

1. Aboveground biomass harvesting is 98% mechanized cut-to-length (CTL), 2% manual power sawing.
2. All biomass is left to season in the forest to dry to 40% moisture content.
3. SRF/*E. nitens* biomass yields based on literature, solid over bark (o.b.)
4. Irish grown *E.nitens* basic density = 435 kg/m^3
5. Irish grown Sitka spruce (SS) basic density = 380 kg/m^3
6. Solid biomass to woodchip/hogfuel conversion factors are based on Irish data.
7. Transport of machinery and materials is included in each life cycle process.
8. SRF biomass yields for each rotation are the same.
9. SS biomass yields based on GROWFOR modelling of Dooary, Co. Laois site.
10. SS available biomass for bioenergy consists only of thinning and/or clearfell pulpwood (7-13 cm diameter), all other roundwood goes to sawmills.
11. GHG balance related to direct land use change (LUC) is included, indirect LUC is not.
12. The SRF and SS biomass end-use is for co-firing with peat at the Biord na Mona operated Edenderry Power Ltd (EPL).

SRF harvesting operations:

Stems, whole-tree, and stumps

LCA: System boundary and scenarios



SRF & SS biomass yields (solid m^3 o.b. ha^{-1})

SRF Assortments	SRF stem-only	SRF wholetree	SRF stump [1]	Total SRF wholetree & stump biomass
Clearfell rotation #1 (10 yrs)	280	350	35	385
Clearfell rotation #2 (20 yrs)	280	350	35	385
Clearfell rotation #3 (30 yrs)	280	350	35	385
Total biomass: 3 rotations	**840**	**1050**	**105**	**1155**
Incl. biomass losses of 12 % [2]	**739**	**924**	**92**	**1016**

SS Assortments	SS totals: aboveground biomass	SS Roundwood (14 - > 20 cm)	SS Clearfell Residues	SS Pulpwood (7 - 13 cm) + Residues
SS Thin #1 (18 yrs)	50	20		30
SS Thin #2 (22 yrs)	50	31		19
SS Thin #3 (26 yrs)	50	37		13
SS Thin total	**150**	**88**		**62**
SS Clearfell (30 yrs)	**521**	**503**		**18**
SS Thin x3 + Clearfell at 30 yrs	**671**	**591**		**80**
SS clearfell brash [3]			156	**86**
SS clearfell stump [4]			115	**48**
Total above & belowground biomass	**942**			**214**

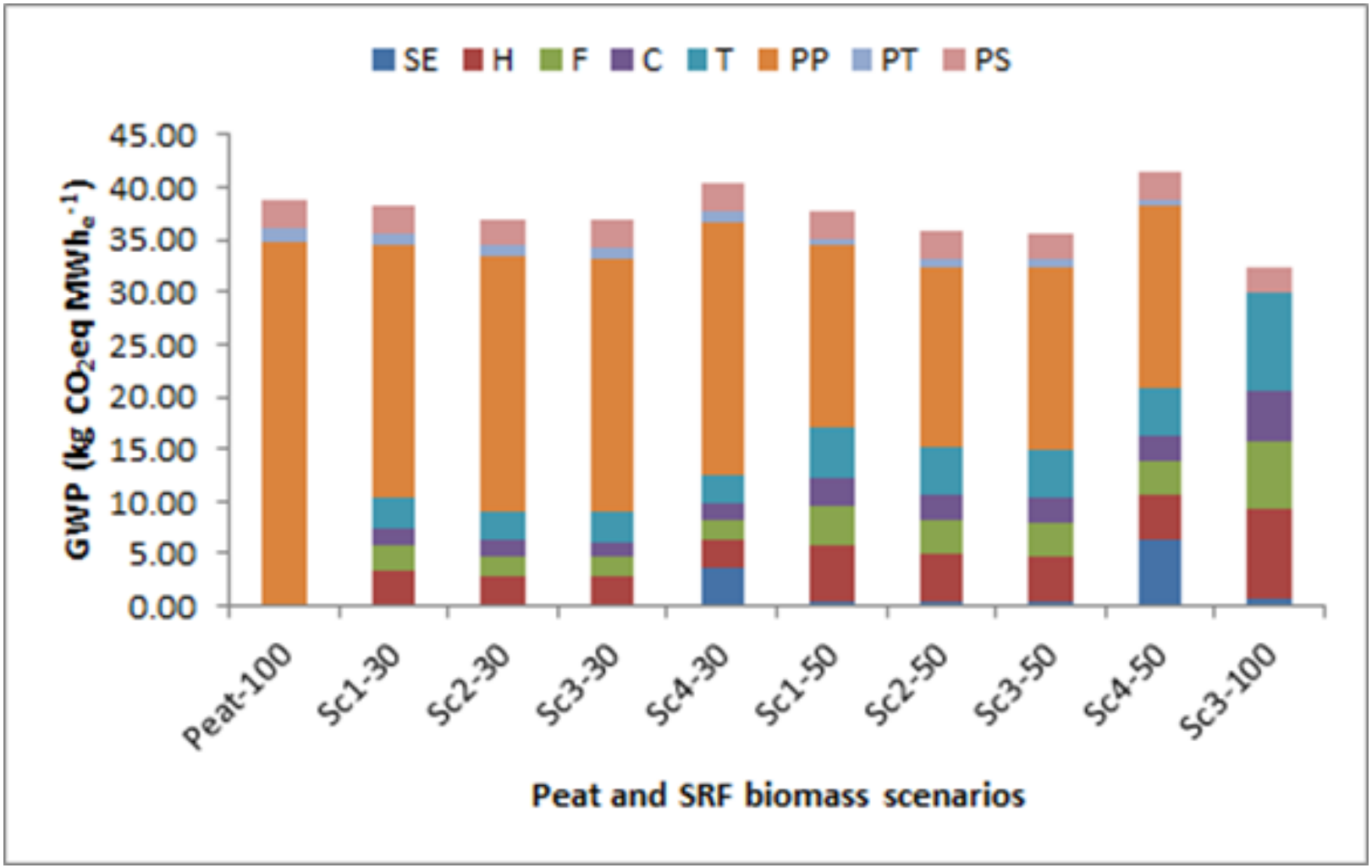
[1] SRF stump (available yield = 22.5% of wholetree, only 50% removed)

[2] Incl. Coillte mean harvesting loss of 9%, + chronic access reduction of 3%

[3] SS brash (available yield = 30% of clearfell ABG, only 55% removed)

[4] SS stump (available yield = 22% of clearfell ABG, only 42% removed)

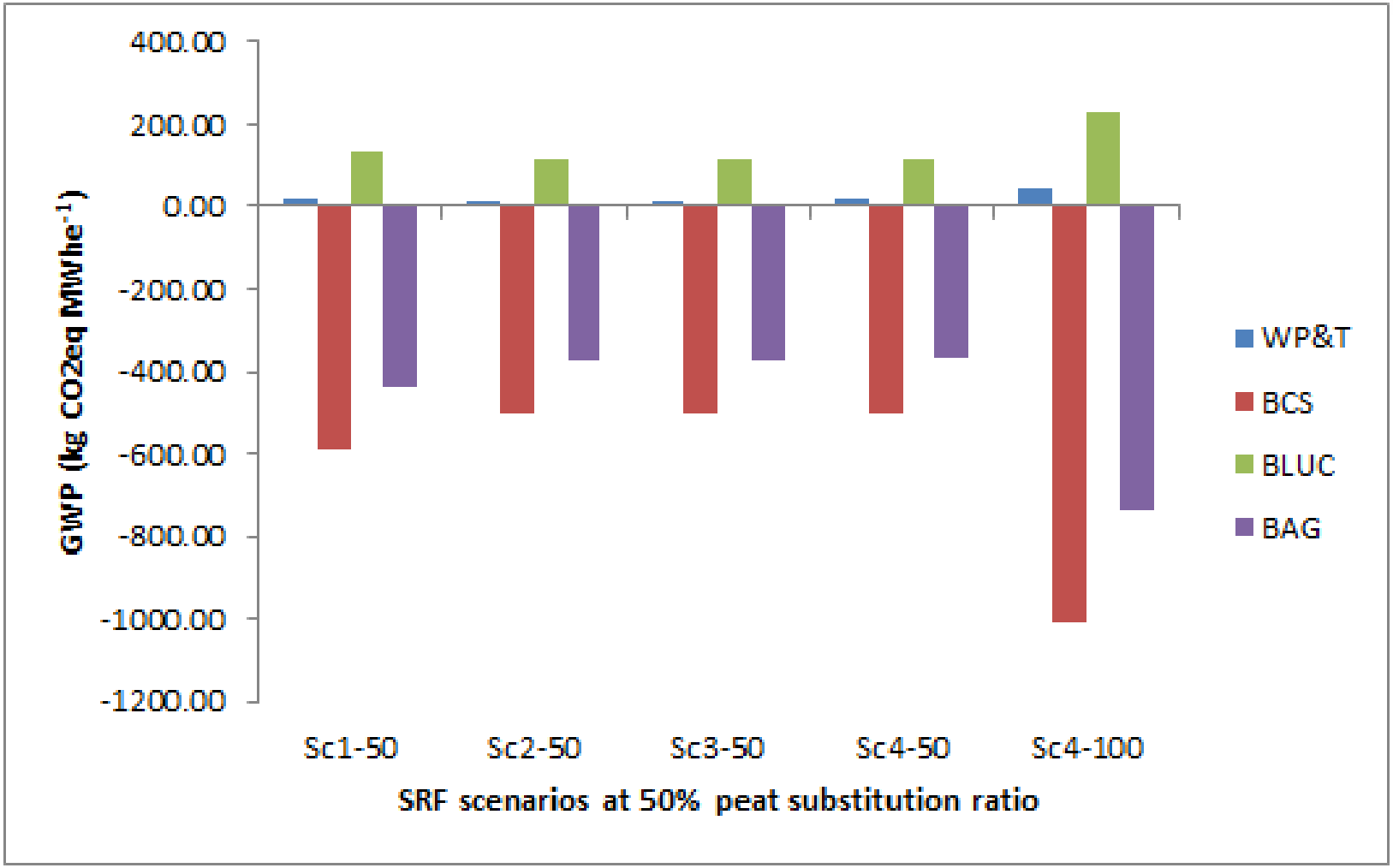
LCA results - GWP: Peat and SRF biomass production, using peat substitution ratios of 0, 30, 50, and 100 %



SE=site establishment, H=harvesting, F=forwarding, C=chipping, T=transport, PP=peat production, PT=peat transport, PS=power station infrastructure

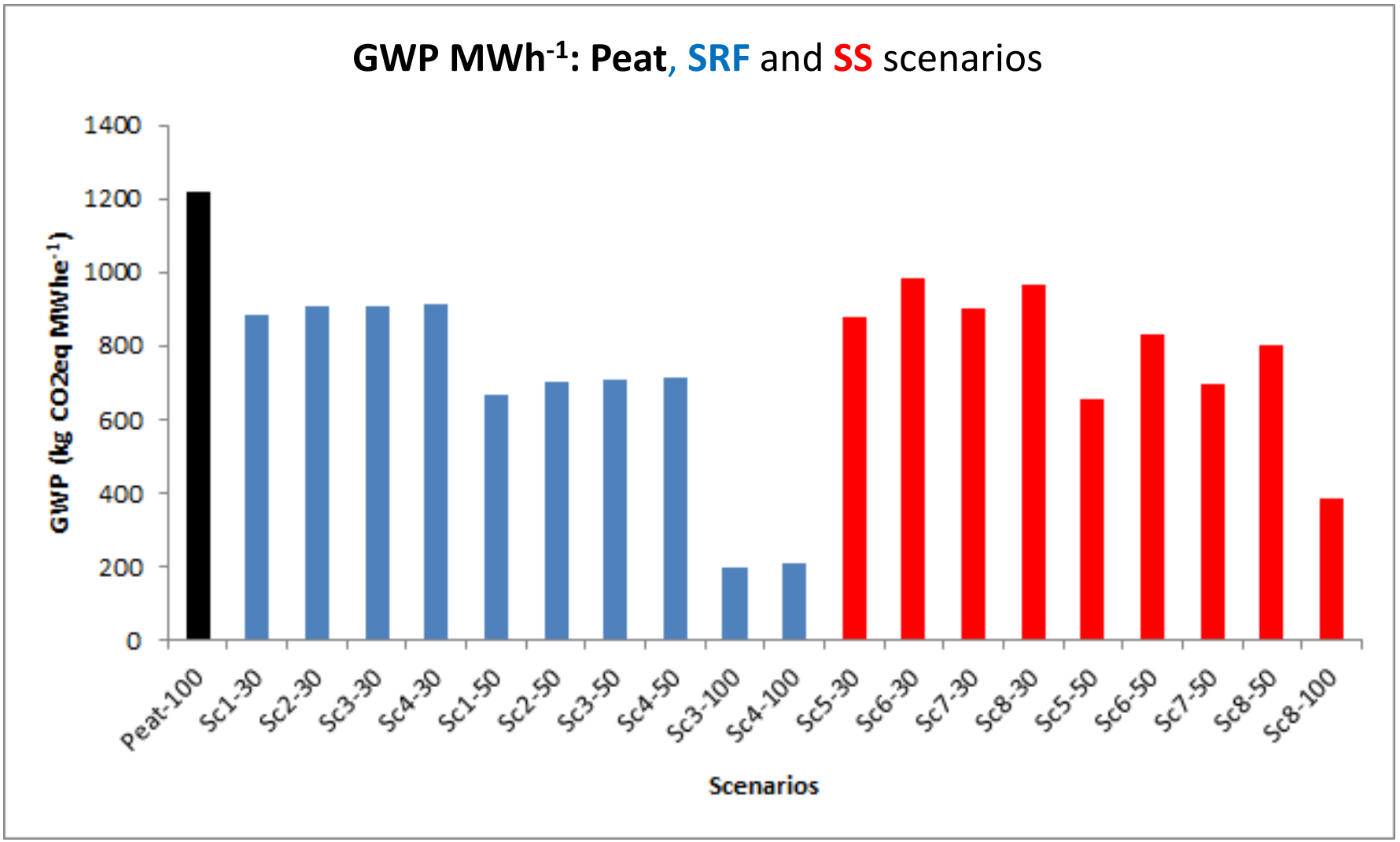
LCA results – GWP:

SRF biomass at the gate

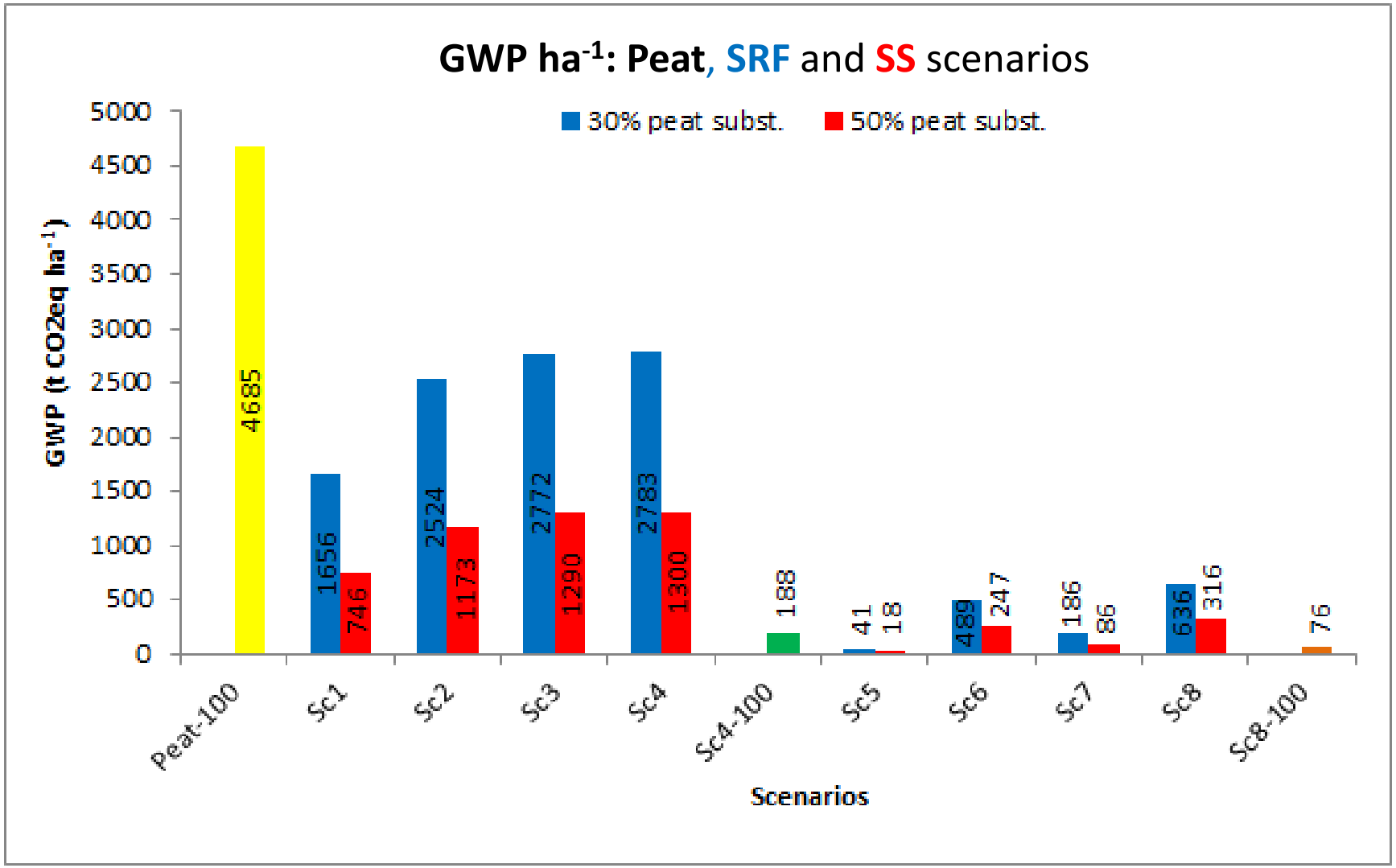


WP&T=wood production and transport, BCS=biomass carbon sequestration, BLUC=biomass LUC, BAG=biomass at the gate

LCA results: EPL peat co-firing with biomass by scenario, using peat subst. ratios of 30, 50, and 100 %



LCA results: EPL peat substitution with biomass by scenario, using subst. ratios of 30, 50, and 100 %



Summary/Conclusions

- LCA of SRF (E. nitens) and SS (pulpwood & residues) biomass for bioenergy completed for multiple biomass assortments and peat substitution rates.
- Impact of SRF LUC and site disturbance from 10 year rotations has a potentially negative effect on soil carbon stocks
- In contrast, the longer SS rotations (30 yrs.) allow greater accumulation of soil carbon
- Significant offset of peat GHG emissions are possible from SRF & SS biomass

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Acknowledgements

Dr. Ken Byrne (UL), my postgraduate supervisor.

DAFM, for funding the ShortFor project.

Coillte, for forest site access during ShortFor fieldwork.

Enda Coates, Brian Cronin, Tom Kent (WIT) for assistance with ShortFor fieldwork and data.

Rachel Clancy for designing the ShortFor logo.

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Thank you for your attention.