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D3.2 SYNTHESIS REPORT: DISCREPANCIES BETWEEN ECOSYSTEM SERVICE NEEDS AND OUTPUTS UNDER CURRENT FOREST MANAGEMENT MODELS

WP3

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Porto

12/06/2108

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 676754.

Overview of presentations

• Introduction	Maarten Nieuwenhuis
• Cross-country overview of selected important DSS output variables	Maarten Nieuwenhuis
• Ecosystem services	ES Experts
• Synthesis	Peter Biber

Introduction

- Case study countries
- Case study areas
- Global frame scenarios
- Implementation
- Required DSS ourput variables

Case study areas

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(Country code) Name(s)	Area, 1000 ha (% forest)	Forest ownership (%)	Main stakeholders	Main ES	Available DSS(s)
(SWE) Kronoberg county	847 (77)	83 Private 17 Public	FOA[1], ENGO[2], forest industry, Swedish Forest Agency, public	Timber, Biodiversity, Water, Recreation	Heureka HoSim
(LTU) Telšiai	254 (34)	63 Private 37 Public	Institute of Forest Management Planning, state forest managers, PFO[3], ENGO, regional park	Timber, Biodiversity Water, Recreation	Kupolis
(SVK) Podpolanie	34 (57)	7 Private 93 Public	State forest managers, PFO, ENGO, general public	Timber, Biodiversity Water, Recreation	Sibyla
(IRL) Barony of Moycullen	81 (16)	22 Private 78 Public	Forest service, advisory services, PFO, ENGO, industries, public, fisheries, investment bodies	Timber, Biodiversity Water, Recreation	Growfor Remsoft
(ITA) Veneto	76 (100)	74 Private 26 Public	PFO, logging enterprises, municipalities, regional forest administration, ENGO	Timber, Biodiversity Water, Erosion control	InVEST RockyFO CO2Fix
(PRT) Sousa Valley	15 (10)	100 Private 0 Public	FOA, forest owner federation, forest industry, forest service, local municipality, other NGO	Timber, Recreation	StandSim SADfLOR
(DEU) Augsburg Western Forests (AWF)	150 (33)	50 Private 50 Public	PFO, ENGOs, forest service forest industry, general public (stable ownership structure for decades)	Timber, Biodiversity, Recreation, Water, Soil protection	SILVA
(DEU) Lieberose - Schlaubetal (LS)	90 (37)	44 Private 56 Public	PFO (their share steadily increasing), forest service ENGOs, forest industry, general public	Timber, Biodiversity, Recreation, Soil protection	SILVA
(NLD) Netherlands	3,734 (11)	52private 48 public	Government: National, Regional & Owners: Owner association, State forestry, National Trust, NIPF & General public	Timber, recreation, biodiversity	EFISCEN-space

[1] Forest owners' association; [2] Environmental non-governmental organisation; [3] Private forest owners

Global frame scenarios

- Reference scenario – the scenario for future patterns of activity which assumes that the future is based on historical development, an increase in timber demand, with medium level of residue extraction
- EU Bioenergy scenario – the scenario for future patterns of activity which assumes an increase in biomass demand over time, with a medium level of residue extraction
- Global Bioenergy scenario – the scenario for future patterns of activity which assumes stringent climate change policies worldwide, leading to an increase in biomass demand over time, with a high level of residue extraction

Implementation

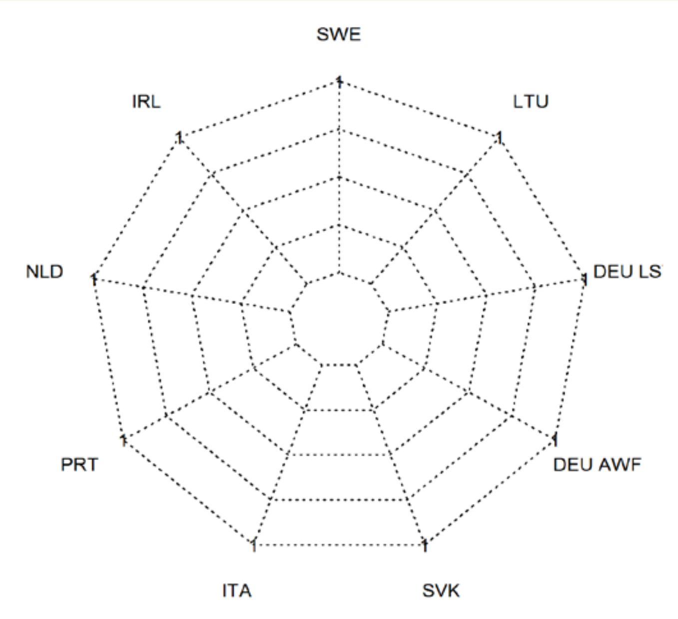
- ALTERFOR, at an early stage, defined a standard set of output variables as a common requirement to be provided by all case studies
- The ALTERFOR Milestone 11, projections with current forest management models (FMM) per case study, was completed on March 1, 2018. It consists of a compilation of DSS results for Current FMMs under the three global frame scenarios.
- The next stage consisted of the local case study coordinators (LCCs) producing assessments of the six ecosystem services (ESs) and timber for their CSAs. The LCCs were facilitated in this by example ES assessments from the ALTERFOR Ecosystem Service Expert Group.
- The ES assessments produced by the LCCs were then sent to the ES Experts, who produced synthesis reports for all ESs, bringing together the most important results and trends from the CSA reports.

Variables needed as output from the DSSs for quantification of the six ESs

Descriptor	Unit	Comment	Timber and biomass	Recreational and aesthetic value	Regulatory services	Carbon sequestration	Water	Biodiversity
Tree species composition	m3/ha (per period)	Per species		x	x		x	x
Tree size diversity	m3/size class (per period)	Suggestion for size classes (diameter in cm): 1-10, 11–20, 21–30, 31-40, 41-50, 51-60, >61		x	x			x
Standing volume	m3/ha and kt/ha (per period)		x			x	x	x
Basal area	m2/ha (per period)				x			x
Tree height	m (per period)	Dominant height			x			
Age	year (per period)	Mean stand age		x	x		x	x
Density/openness	stems/ha or basal area (m2/ha) (per period)	Mean for stand		x	x			x
Large trees	m3/ha (per period)	Per species, suggestion for size classes (diameter in cm): >30 cm, >40cm, >50cm, >60cm						x
Dead wood, logs	m3/ha and kt C/ha (per period)	Per species		x		x		x
Dead wood, stumps and roots	kt C/ha (per period)					x		
Large dead wood	st/ha (per period)	Per species, suggestion for size classes (diameter in cm): >30 cm, >40cm, >50cm, >60cm				x		x
Spatial fragmentation	index value per habitat or forest type (per period)	Aggregation indices are available in GIS, but this should be harmonized between LCCs			x			x
Naturalness	Hemeroby index (per period)	Hemeroby index: 0 = natural, non-disturbed forest, 0.33 = close to natural, 0.66 = semi-natural, 1 = relatively far from natural (monocultures, plantations)		x				
Forest edges	length of edge relative to the landscape area (per period)			x	x			
Diversity of forest stand types	no. of different stand types in the landscape or Shannon's landscape diversity/evenness index (per period)	Definitions of stand types may differ.		x				x
Stand size variation	largest patch index (per period)			x				
Understory	0 (=no)/1 (=yes) or biomass (per period)			x	x			
Heterogeneity	heterogeneity index, i.e., distribution of forest stand types (per period)			x				x
Final felling area	ha (per period)	For uneven-aged forests: size of contiguous harvested areas. For shelterwood: two figures regarding harvested area / time period are given		x			x	x
Protected area	ha (per period)	Area as per IUCN category						x
Afforestation	age of forest cover (per period)	Concerns afforestation of non-forest land, not regeneration after final felling		x				
Residues harvested	m3 or kg/ha, and area where residues are harvested (per period)	In final felling (and thinning if possible/applicable, but these should be separated)	x	x		x		
Below ground biomass	kt C/ha (per period)					x		
Harvested wood, total	m3/ha (per period)		x			x	x	x
Volume harvested by assortments (sawlog, pulpwood)	m3/ha and kt C/ha (per period)		x			x		
Fertilization (nitrogen and/or phosphorus)	kg/ha and area fertilized (per period)						x	x

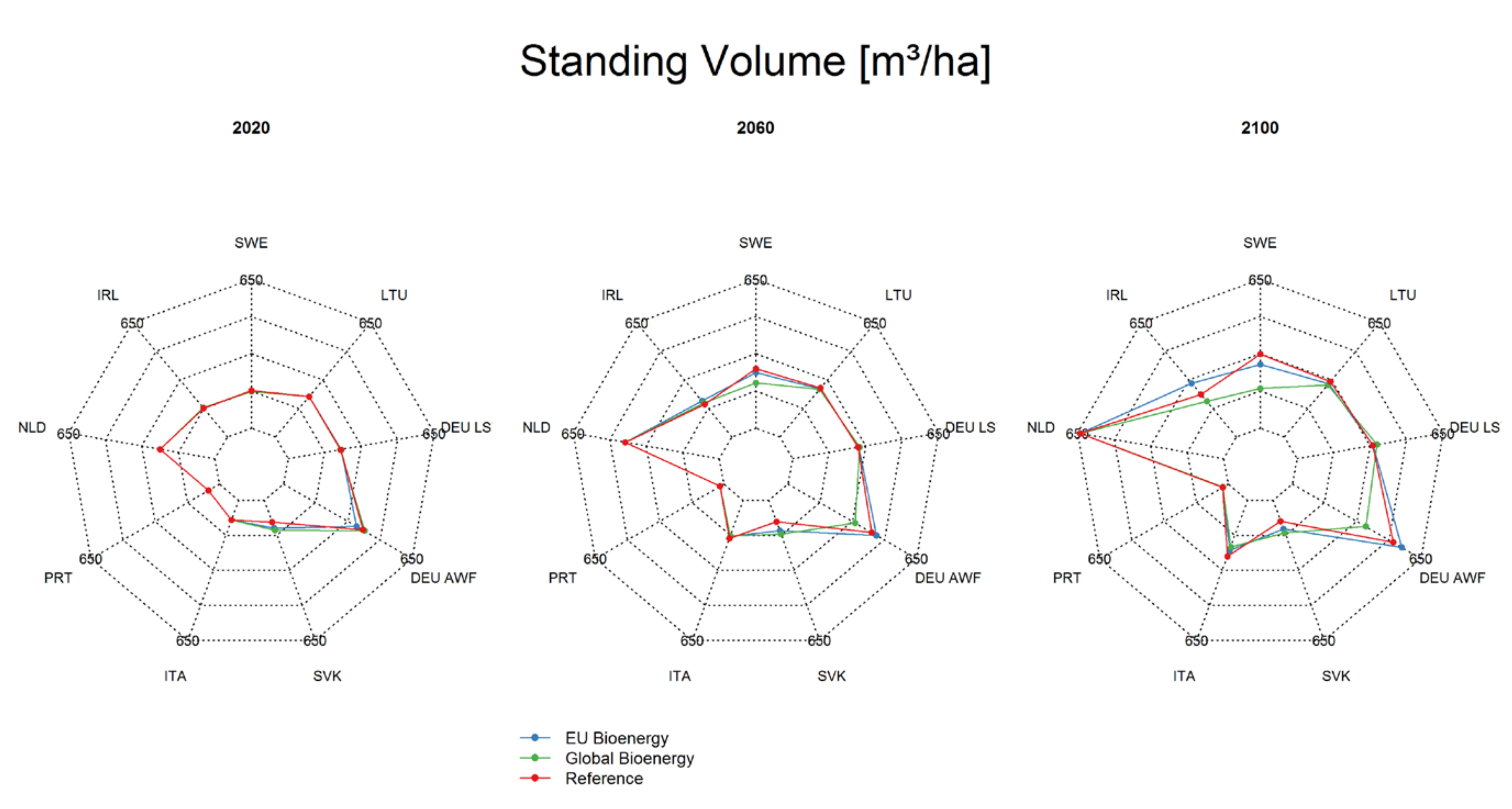
Cross-country overview of selected important DSS output variables and their projected development under current FMMs

- The result presentation uses so-called spider diagrams, all based the same layout. This diagram layout provides a separate axis for each case study along which the variable of interest is plotted. The axis directions roughly mirror the North-West/East-South order of the case studies



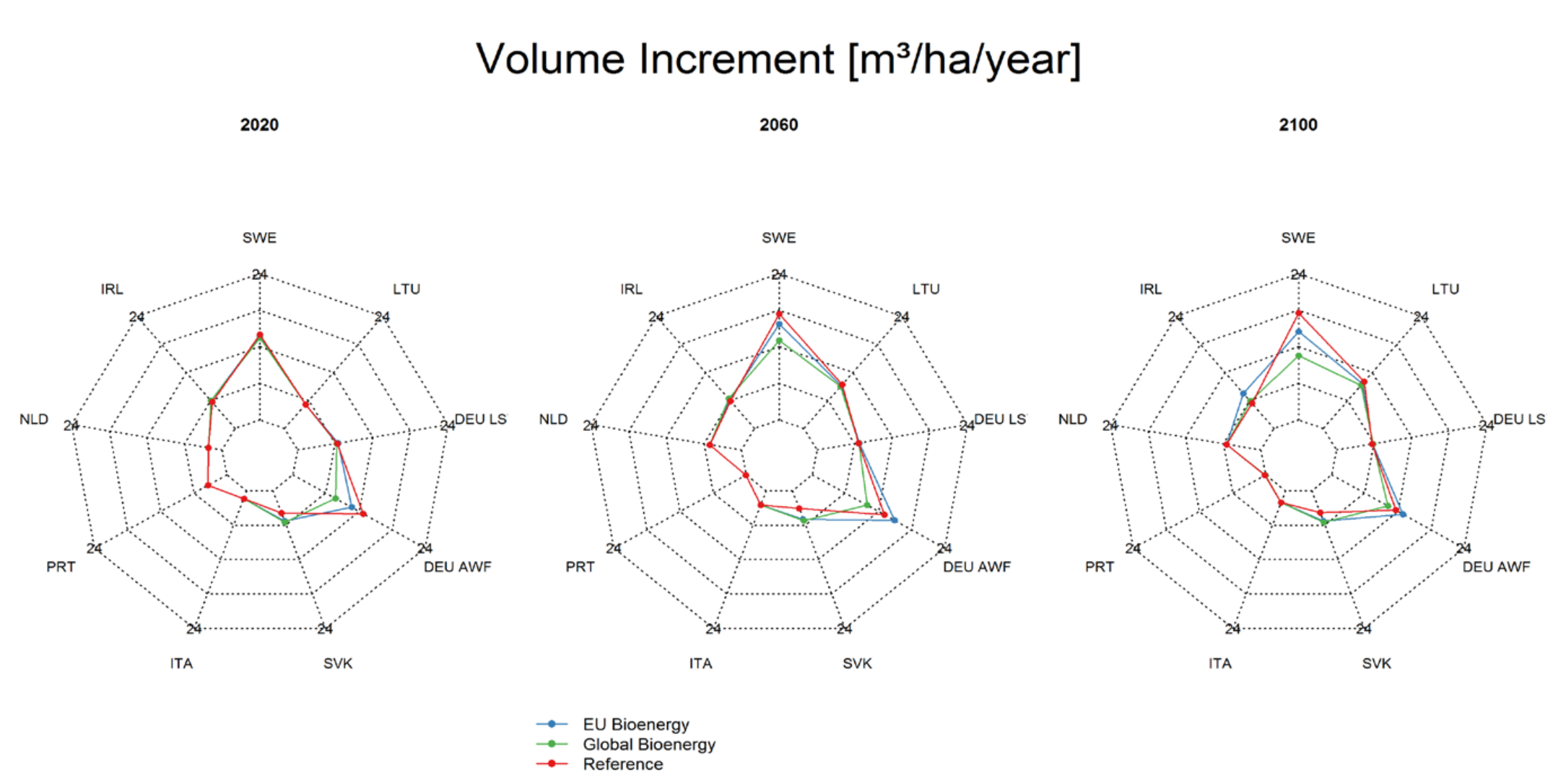
- The results are grouped into three sections: a) Classic Forestry Information, b) Structure and Diversity, and c) Carbon Sequestration related information.

Classic Forestry Information



The standing wood volumes are increasing in almost each case study (exceptions are Portugal and Slovakia), most pronounced in the Netherlands, Sweden, and the Southern German case study Augsburg Western Forests (AWF)

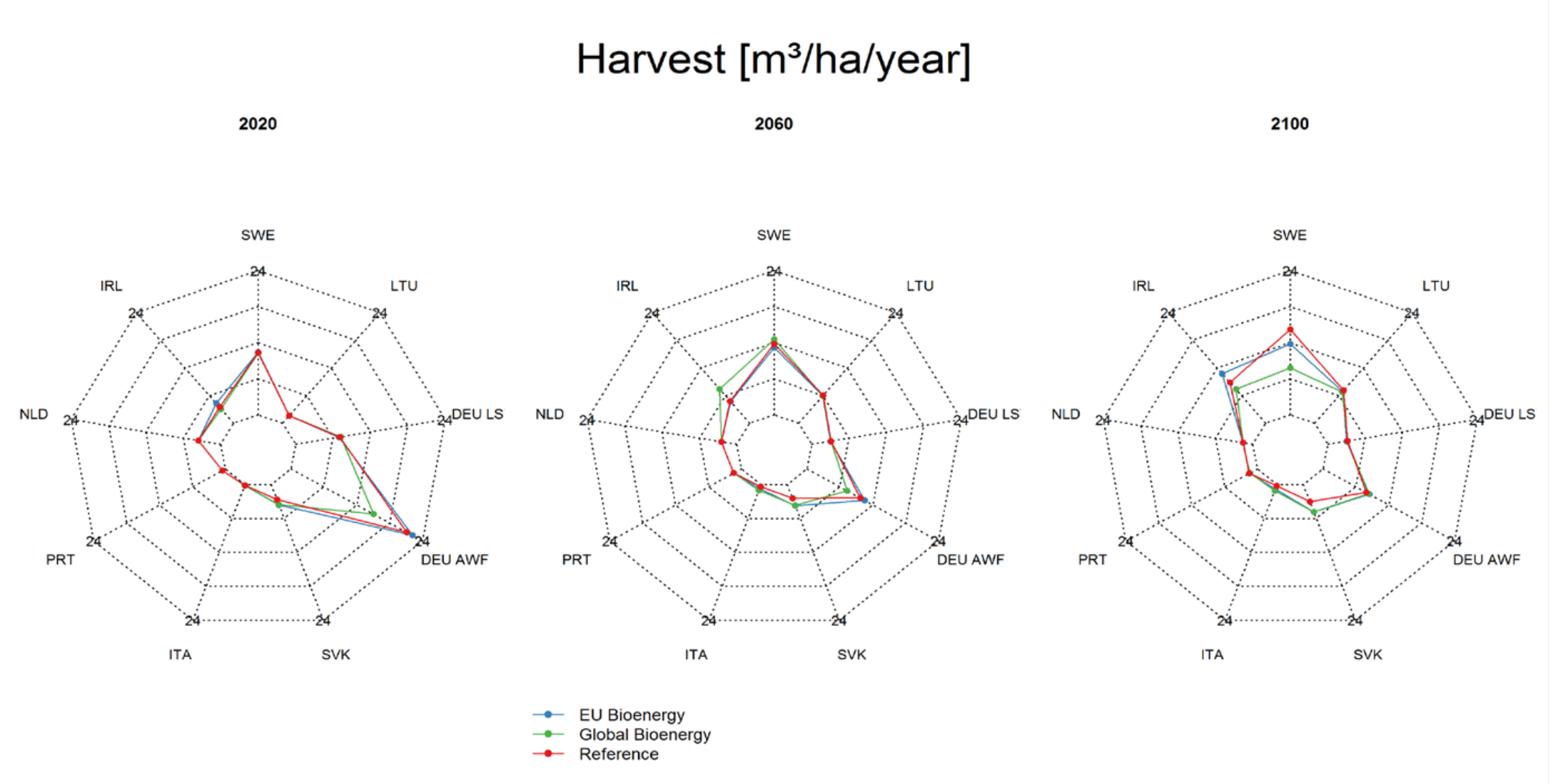
Classic Forestry Information (cont.)



The volume increments generally show a slightly increasing trend for almost all case studies

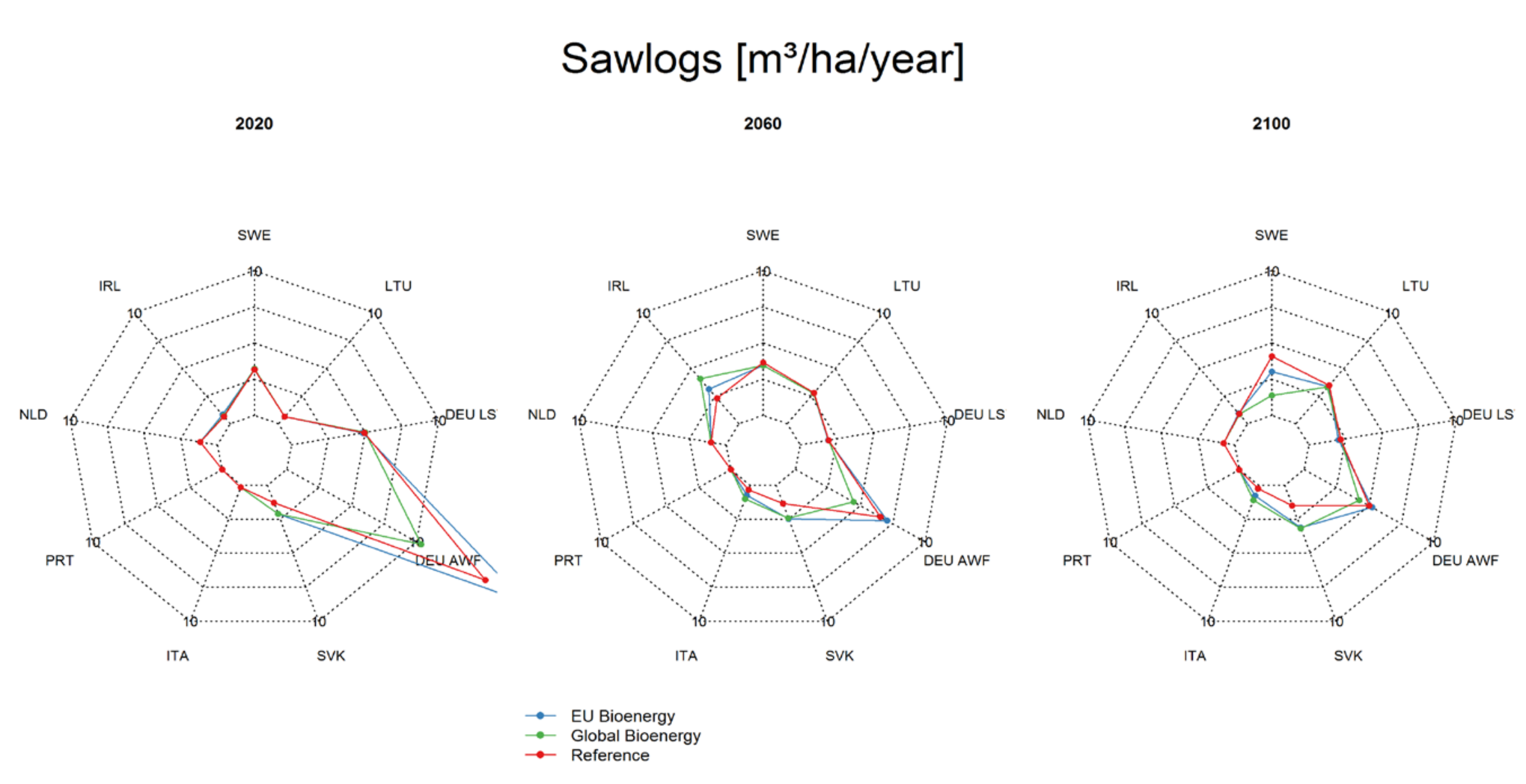
In later years, scenario differences emerge: the lowest increments in Sweden and Germany AWF for the Global Bioenergy scenario, and in Ireland and Slovakia for the Reference scenario

Classic Forestry Information (cont.)



The harvest volumes stay virtually always below the increments, explaining the consistent increase of standing volumes. The only exception is the German AWF case study. Scenario differentiation is almost not existing in the beginning but becomes more pronounced later in some countries

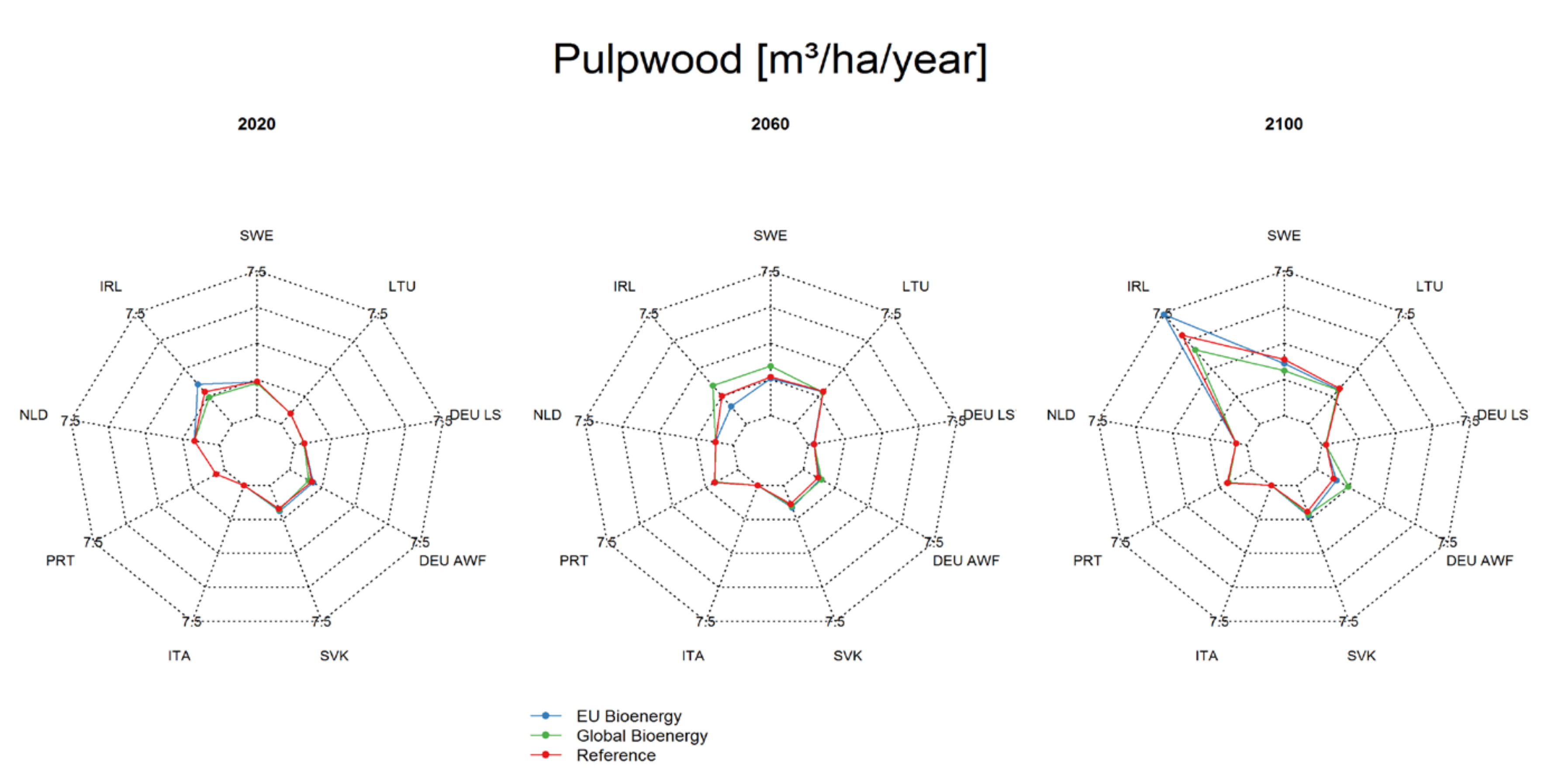
Classic Forestry Information (cont.)



Sawlog production is relevant in some of the case studies only (Sweden, Lithuania, Germany, Slovakia, temporarily Ireland).

In the German AWF case study, the initial great sawlog volume comes from mature stands.

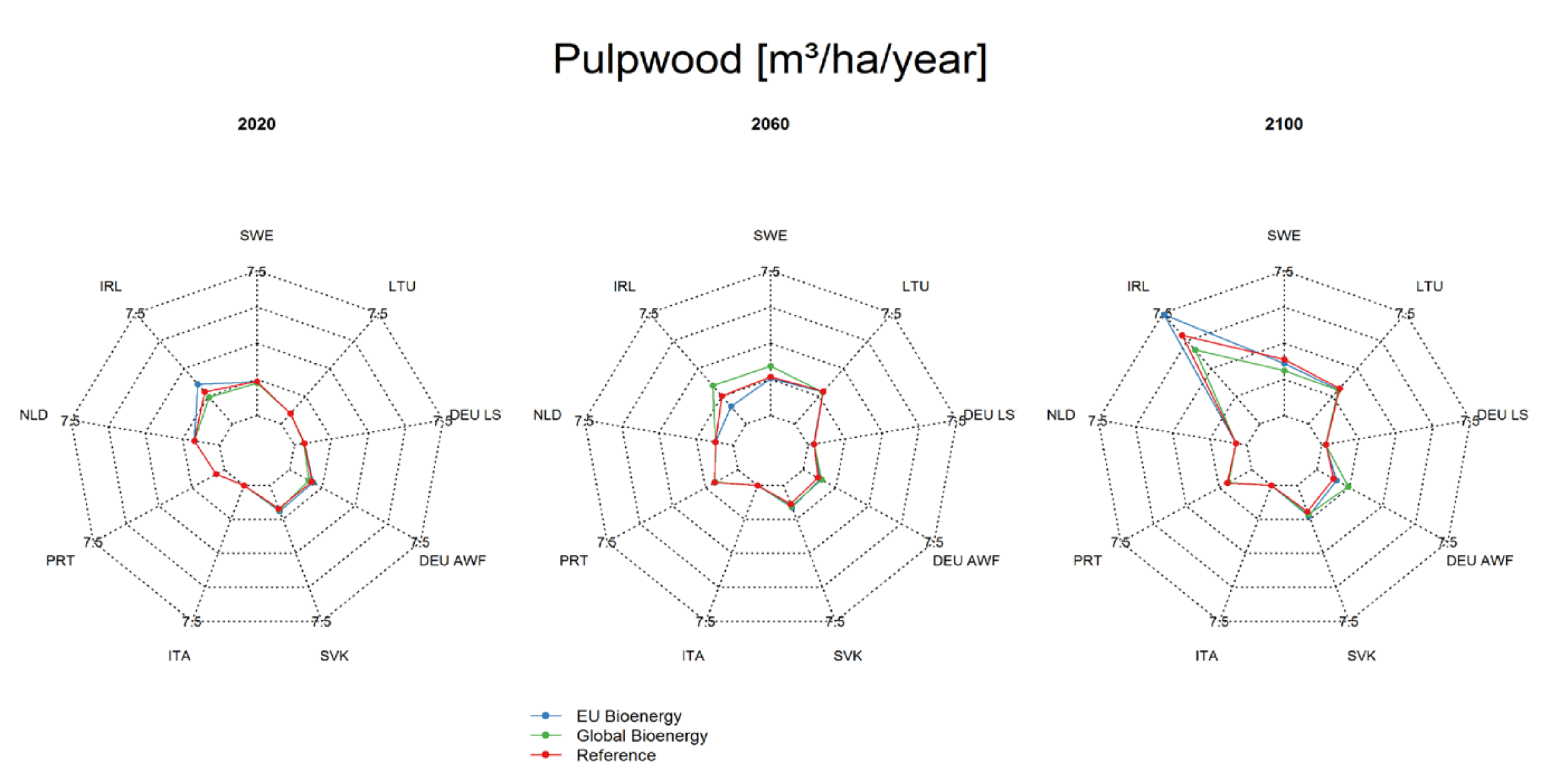
Classic Forestry Information (cont.)



Strong increases, most prominently in Ireland, but also in Sweden, Lithuania and Portugal; a reduction in the Netherlands.

Scenario differentiation is heterogeneous across countries; however, in Germany AWF, Slovakia, and Ireland there is a common trend towards more pulpwood in the EU Bioenergy and partly the Global Bioenergy scenario compared to the Reference scenario.

Classic Forestry Information (cont.)



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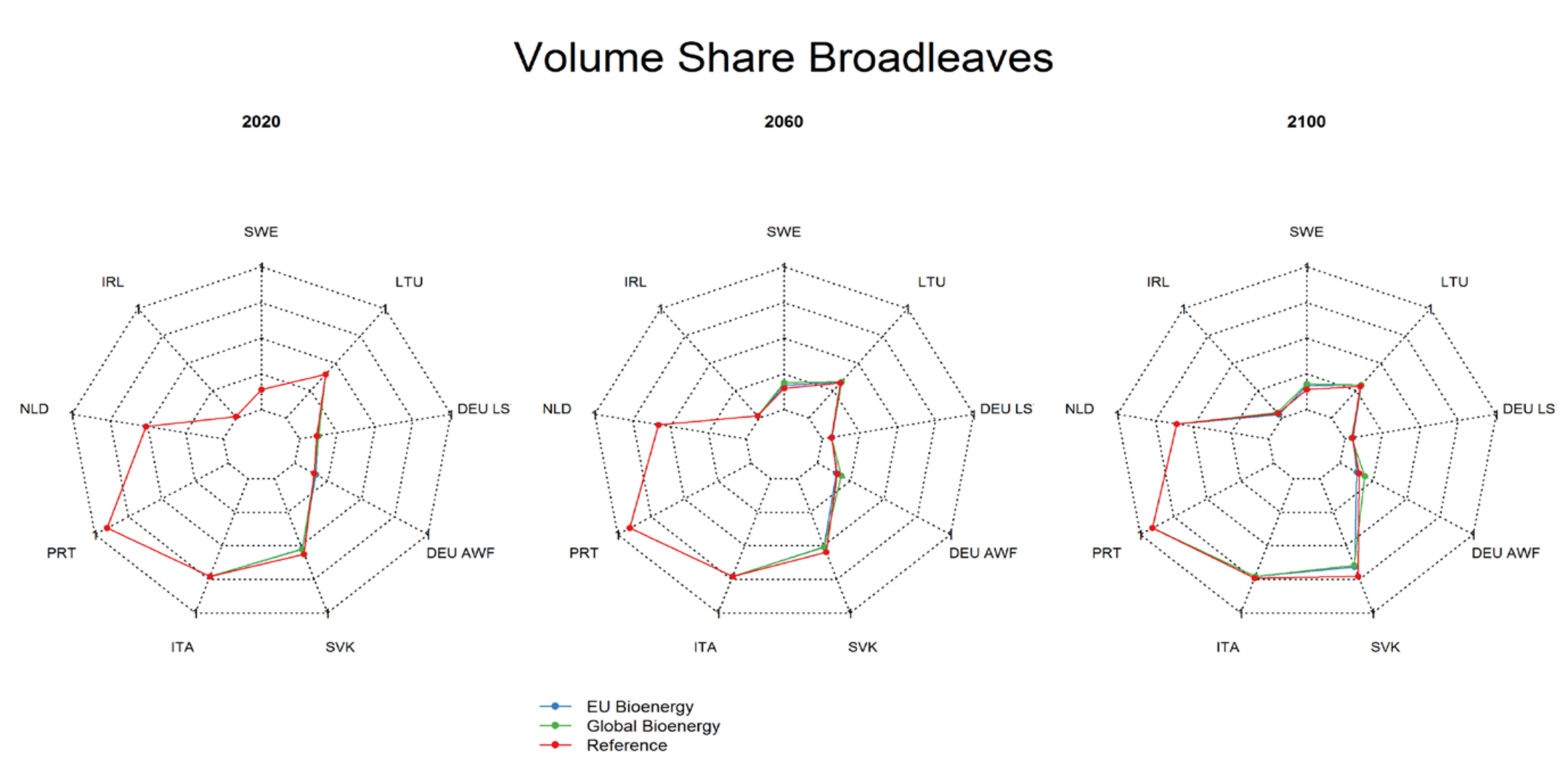
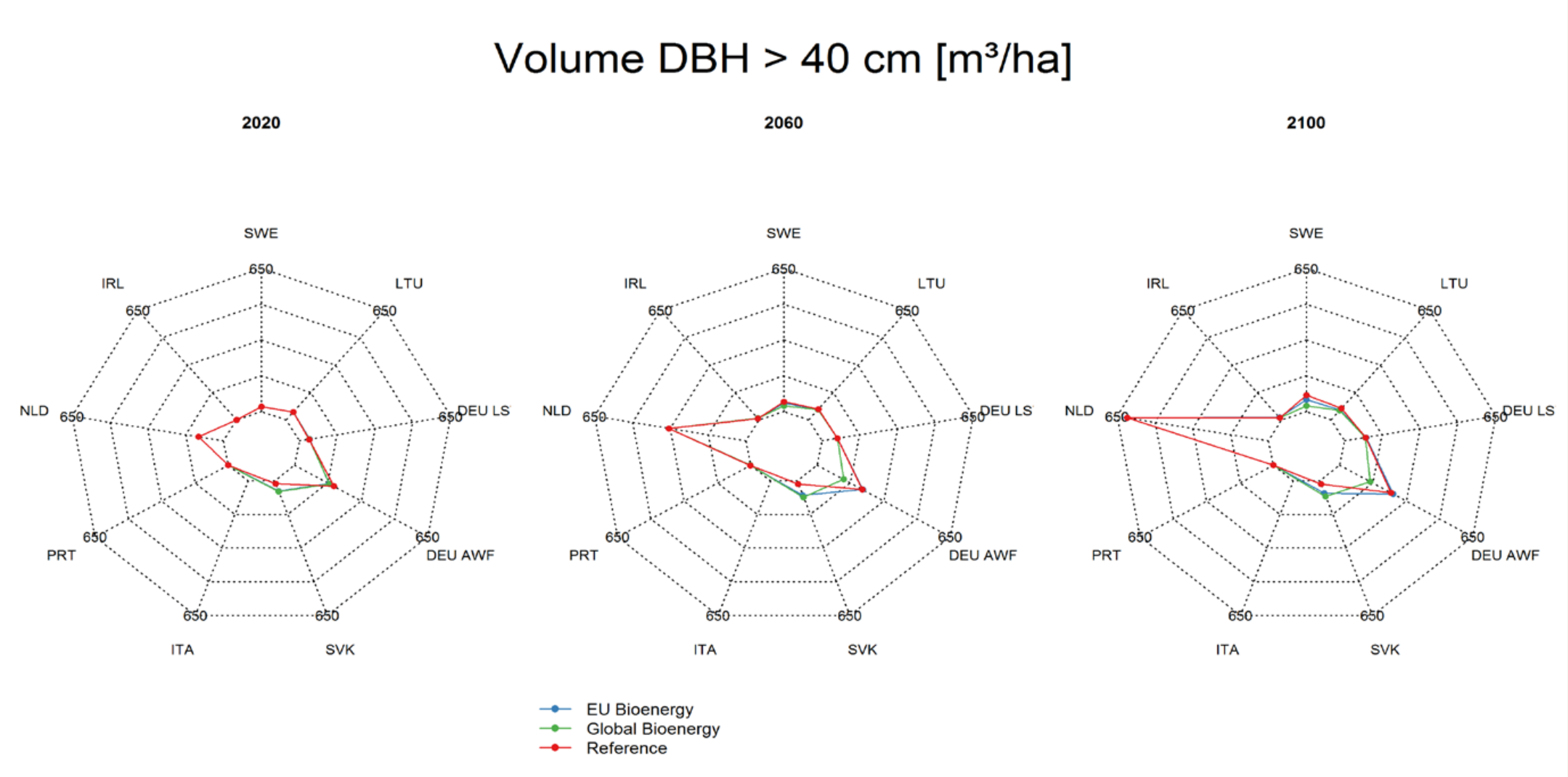
Structure and diversity



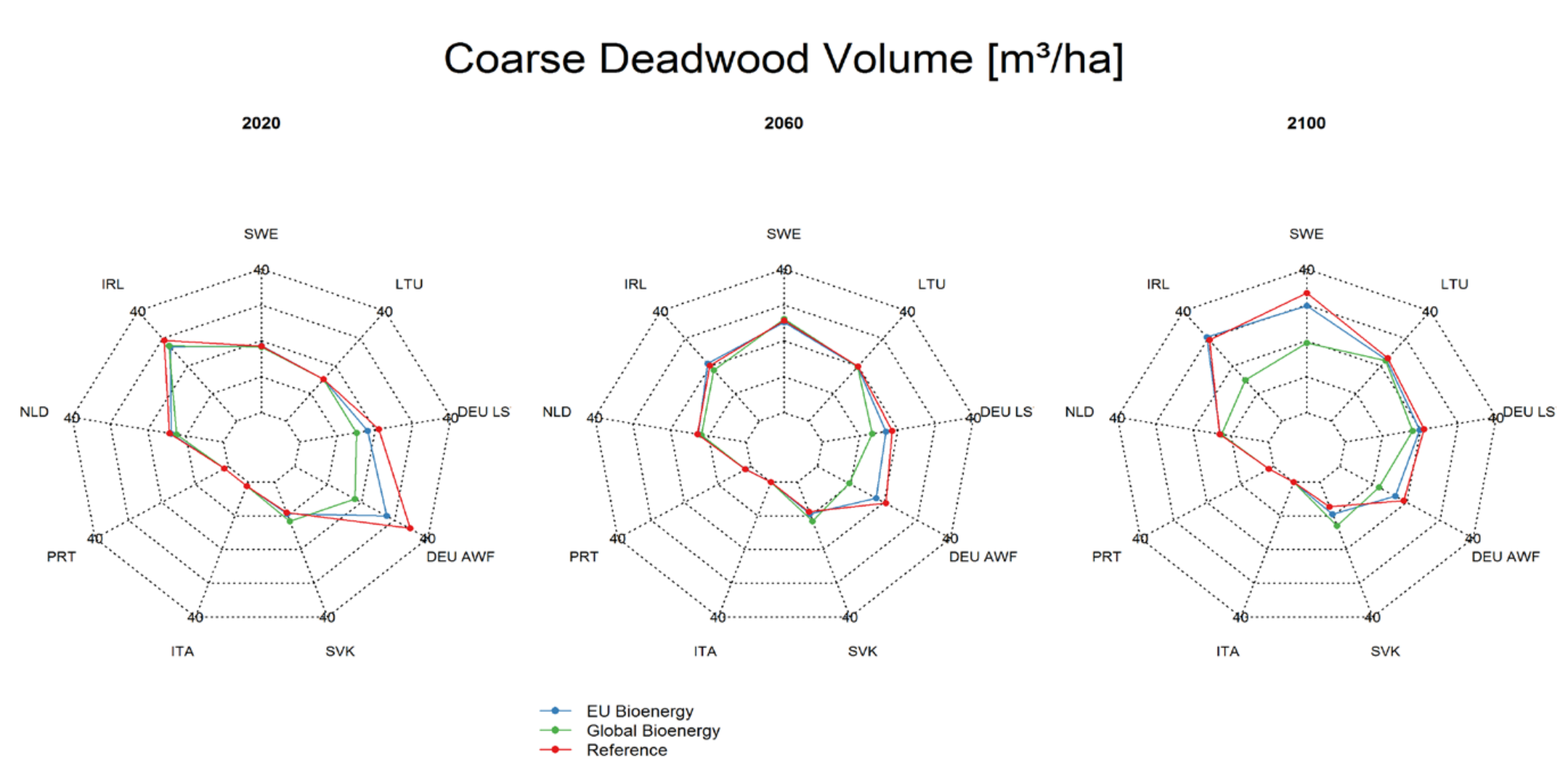
The share of broadleaves does not only mirror local forest history, but also site conditions.

Structure and diversity (cont.)



In most countries, this volume is slightly increasing; a dramatic increase was obtained for the Netherlands where by 2100 the whole forest landscape is dominated by large trees. A scenario differentiation over time is observed for Sweden, Germany AWF, and Slovakia. In the former two cases the highest large tree volumes are obtained in the Reference scenario, while in Slovakia the Reference scenario results in the lowest values.

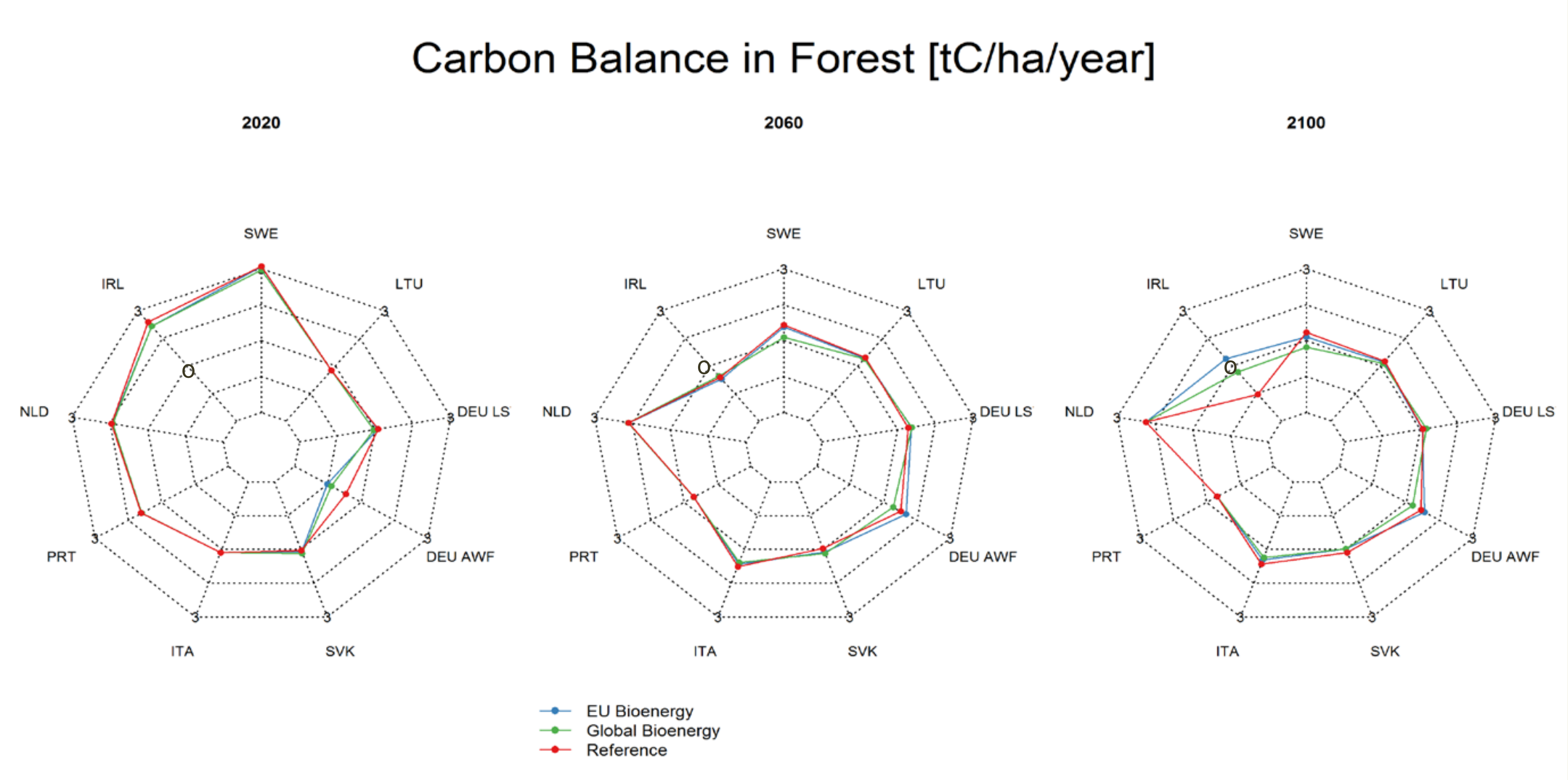
Structure and diversity (cont.)



Values are quite stable at a low to medium level in Italy, Portugal, the Netherlands, and Germany LST. In Ireland an interim minimum increases to comparably high values in the Reference and the EU Bioenergy scenario.

In Ireland but also in Sweden and Germany AWF, there is a distinct scenario differentiation, where in the Global Bioenergy Scenario – due to a higher degree of energy wood use – the lowest deadwood volumes accumulate.

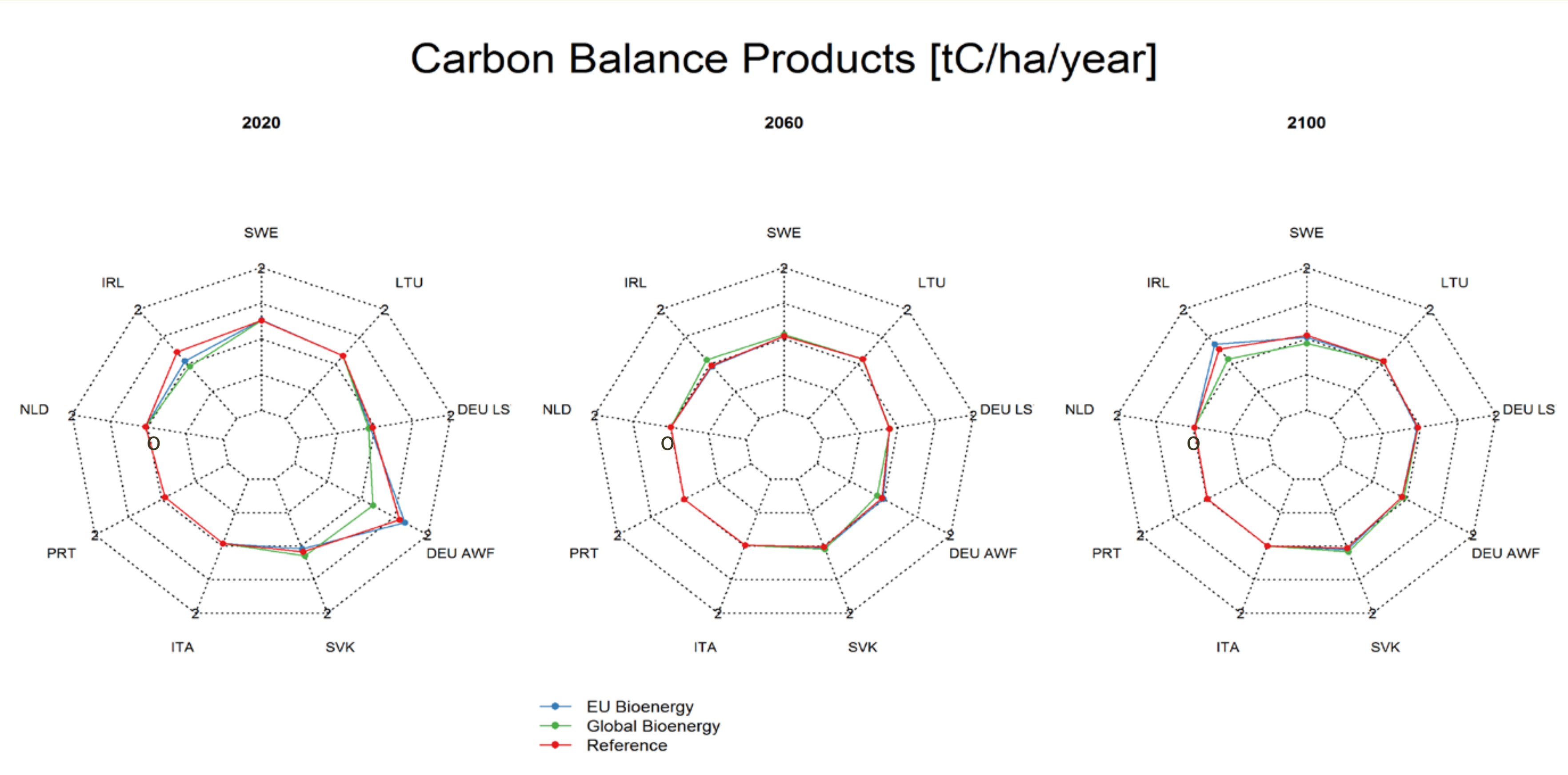
Carbon Related Variables



Initially, Lithuania, Slovakia, and Italy have a near zero balance, while it is negative for Germany AWF and considerable positive (i.e. net carbon uptake) in Ireland, Portugal, the Netherlands and Sweden.

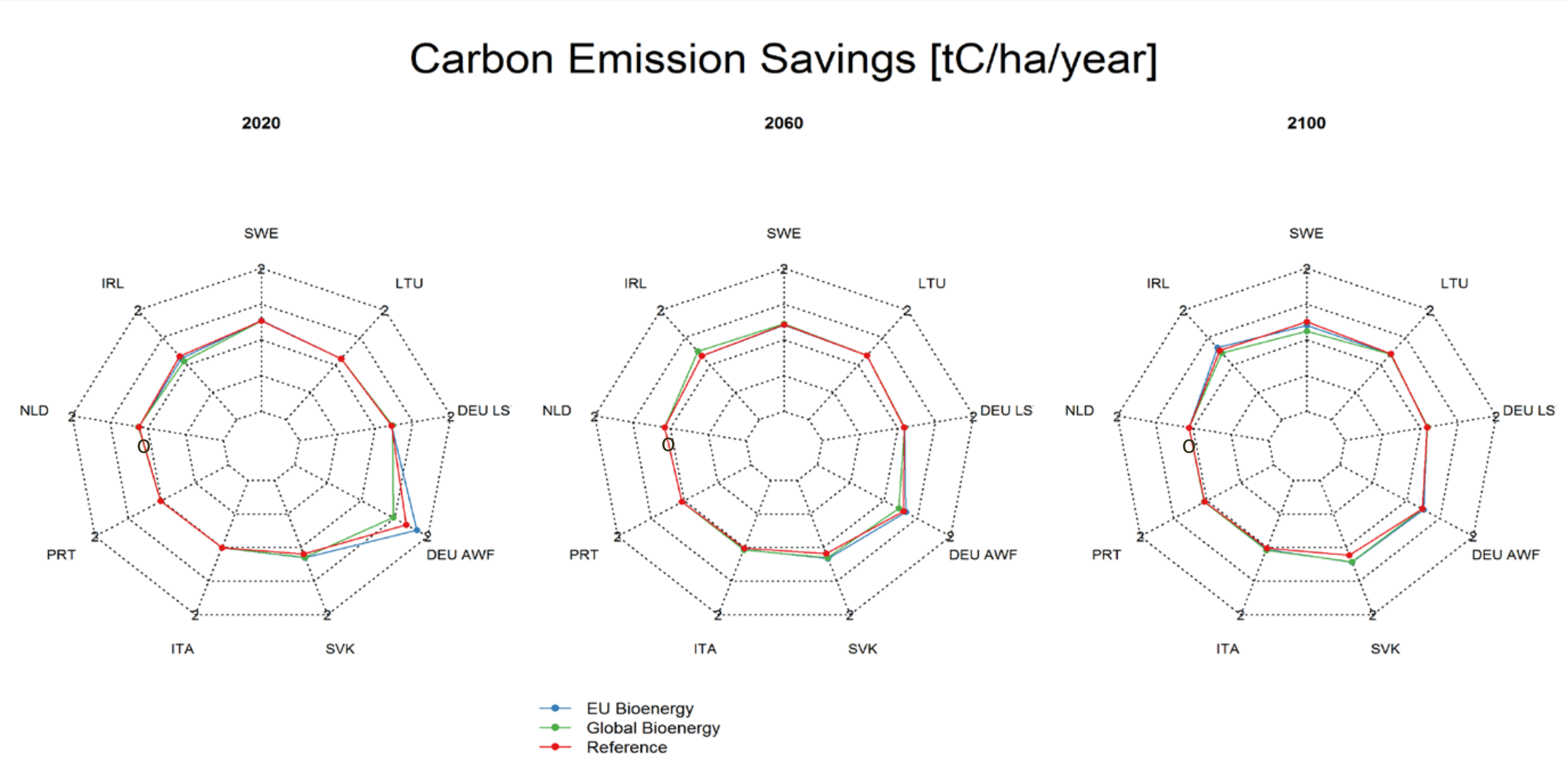
Scenario differences are generally weak, except for Ireland. Weaker, but still considerable scenario differentiations were obtained for Sweden and Germany AWF.

Carbon Related Variables (cont.)



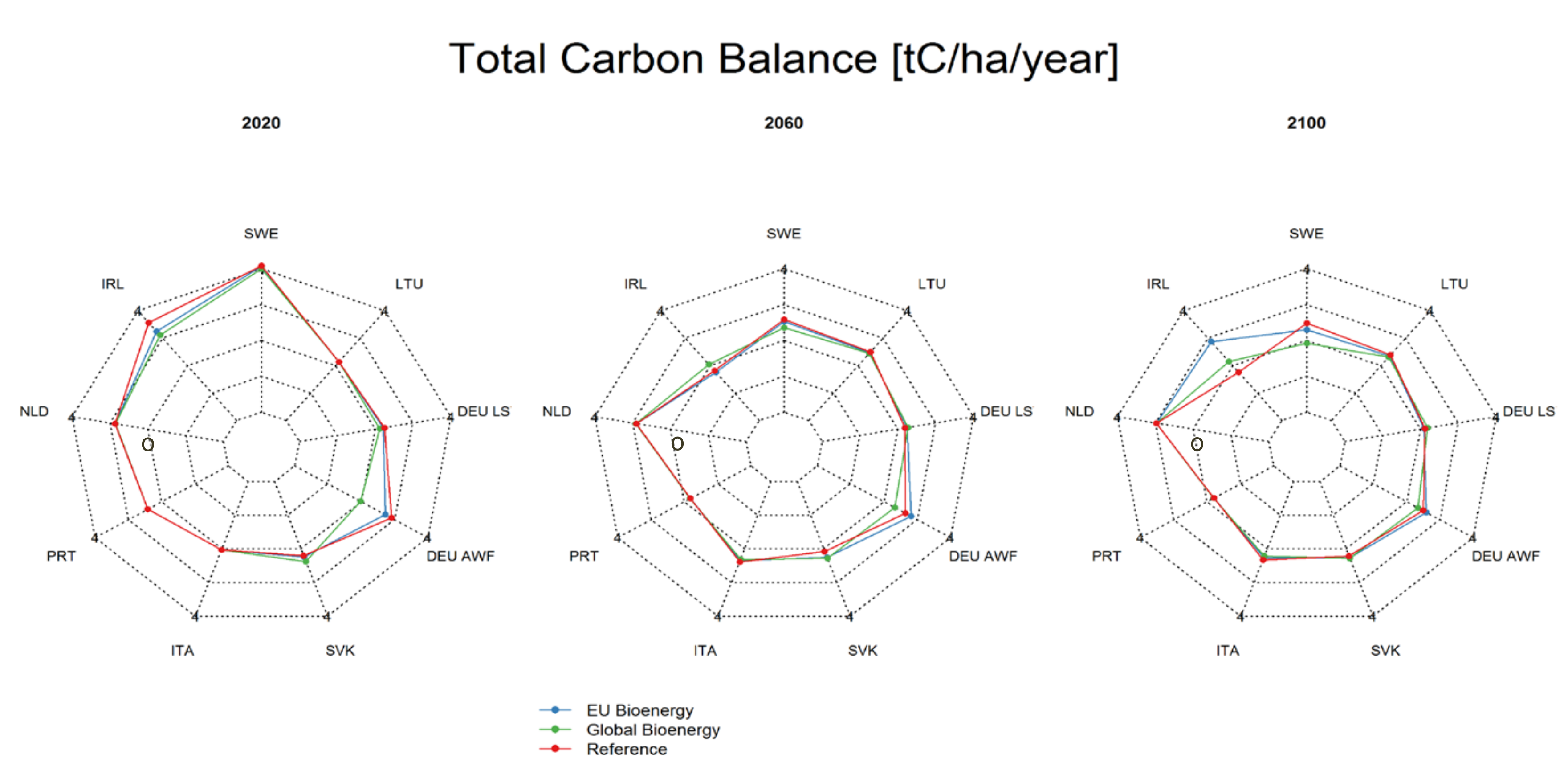
The results do not show considerable scenario differentiation, except for Ireland with the lowest values for the Global Bioenergy scenario in the long run.
While a few case studies (Sweden, Lithuania, Germany AWF, Ireland) have distinctly positive or negative balances in the beginning, consistent zero balances are obtained later; only Ireland returns to a positive balance for the Reference and the EU Bioenergy scenarios.

Carbon Related Variables (cont.)



We observe a convergence of the different case studies, with positive values (i.e. actual emission savings) prevailing still at the end of the simulation for Sweden, Lithuania, Germany LST and AWF, Slovakia, and Ireland. In the other case studies the emission savings are virtually zero.

Carbon Related Variables (cont.)



A general trend of convergence across the case studies to a total C balance between about 0 and 2 tC/ha/year.

A pronounced scenario differentiation was observed only for Ireland.

The reasons for the long-term positive carbon balances are different, depending on the relative importance of the three sub balances (forest C-stocks, product C-stocks, and emission savings).

Conclusions

Based on all results presented above:

- The differences obtained for the global frame scenarios are not very pronounced,
- There are considerable differences across the case studies.
- Remarkably homogeneous trends among the case studies are:
    - consistent increases of standing volume
    - zero or positive carbon balances
    - structural and diversity related variable values mostly stable or even increasing

TIMBER PROVISION

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Harvest volume

- No uniform trends were found in harvest volumes over time between CSAs or between scenarios.
- The actual trends are the result of many factors interacting, such as:
  - the impacts of climate change on growth rates and increment,
  - the different trends in timber prices and demands in the different CSAs
  - the response of forest owners to these trends
  - and a number of CSA-specific developments, such as the prohibition on fertilisation in the Irish CSA.
- In several CSs, the harvest volumes are increasing over time, such as in Italy, Lithuania and Portugal, while in other CSAs the volumes decrease over time, such as in the two German case studies, the Netherlands, Portugal and in Sweden for the Global Bioenergy scenario.
- In most CSAs, there are no large difference between harvest volumes in the different scenarios.

Harvest volume (cont.)

- Increasing, decreasing or stabilising volume trends have different trajectories in some areas. For example:
  - In the German Augsburg Western CSA, the stabilising volume trend to 8 m^3 ha^{-1} yr^{-1} takes longer in the Global Bioenergy scenario than in the other two scenarios.
  - In Ireland, the harvest level depends on the presence or absence of a harvest moratorium in the Freshwater pearl mussel area and fluctuates widely over the simulation period in all three scenarios, between values of 2 and 11 m^3 ha^{-1} yr^{-1}, reflecting the (rather uniform) age class distribution of the forests over time.
  - In Lithuania, potential harvest volumes increase on average from 4 to 7 m^3 ha^{-1} yr^{-1}, with the increase for the Reference scenario slightly higher to 7.5 m^3 ha^{-1} yr^{-1}. The Global Bioenergy harvest volume increase is the smallest because of less beneficial climate change effects.
  - In Slovakia, harvest volumes for the EU Bioenergy and Global Bioenergy scenarios are equal (between 4 and 4.5 m^3 ha^{-1} yr^{-1}), but much higher than for the Reference scenario (3 m^3 ha^{-1} yr^{-1}).

Assortment volumes

- Different trends are found between CSAs. For example:
  - The proportion of sawlog decreasing in Ireland over time, while in Lithuania sawlog and residues volumes increase and pulpwood volume is constant.
  - In the Swedish CSA, sawlog volume decreases dramatically after 2070 in the Global Bioenergy scenario as all older stands have been harvested.
- These trends are determined by a number of factors, such as the difference between increment and harvest volume, climate change effects, and local issues.

Volume increment

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- No uniform trends were found in increment between CSAs or between scenarios, as the impacts of climate change differ from area to area and between scenarios.
- In some CSAs, the reduced climate change effects in the Global Bioenergy scenario are beneficial for growth while in others the large effects in the Reference scenario lead to increased growth. For example:
  - In the Lithuanian CSA, increment is lowest in Global Bioenergy scenario due to lower climate change effects on yield.
  - In the German Augsburg Western CSA, volume increment is highest in the EU Bioenergy scenario and lowest in the Global Bioenergy scenario.
  - In the Lieberose Slaubetal CSA, volume increment for all scenarios is between 7 and 8 $m^3 ha^{-1} yr^{-1}$ at the start and slowly drops to 6 $m^3 ha^{-1} yr^{-1}$ at the end of the planning period.

Standing volume

- In almost all CSAs standing volumes increase over time, but there are distinct trends between scenarios in several of them. For example:
  - In Italy, standing volume increases from c. 70 m^3 ha^{-1} to 275 m^3 ha^{-1} in the Reference scenario, less so in the Global Bioenergy one (to 230 m^3 ha^{-1}).
  - In the Slovakian CSA, standing volume trends are similar for the EU Bioenergy and Global Bioenergy scenarios and lower for the Reference scenario.
  - In Sweden, the standing volume in the Reference scenario volume ends at 330 m^3 ha^{-1} in 2110, while the EU Bioenergy volume ends at 280 and the Global Bioenergy volume at 180 m^3 ha^{-1}.
  - In the German Lieberose Schlaubetal CSA, harvest volume is below increment, resulting in standing volume increases for all scenarios from 250 m^3 ha^{-1} to 350 m^3 ha^{-1} over the simulation period.

Conclusions

- Despite the heterogeneous trends presented, in no CSA in no scenario does a critical development (i.e. depletion of standing volume) related to (excessive) timber provision occur in the long run.
- In many CSAs, increasing standing volumes due to harvests being lower than the increments indicate a potential for increased sustainable harvest amounts with alternative forest management models, if desired.
- In almost every CSA where there is an increased harvest potential and an evident scenario differentiation, this potential is lowest in the Global Bioenergy scenario.
- It is not clear if the increased demand for timber and the higher timber prices, as indicated in many of the global frame scenarios, are sufficiently reflected in the harvest volume trends in many CSAs.

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D3.2 SYNTHESIS

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What we learned

- Trivial insight first: Results mirror the heterogeneity of forest landscapes and their management throughout Europe

- Less trivial: Frame scenarios (climate and demand) in general without pronounced effects (partly methods, partly inertia of forest systems)

- We expect the aFMMs compared to cFMMs will show stronger effects than the frame scenarios

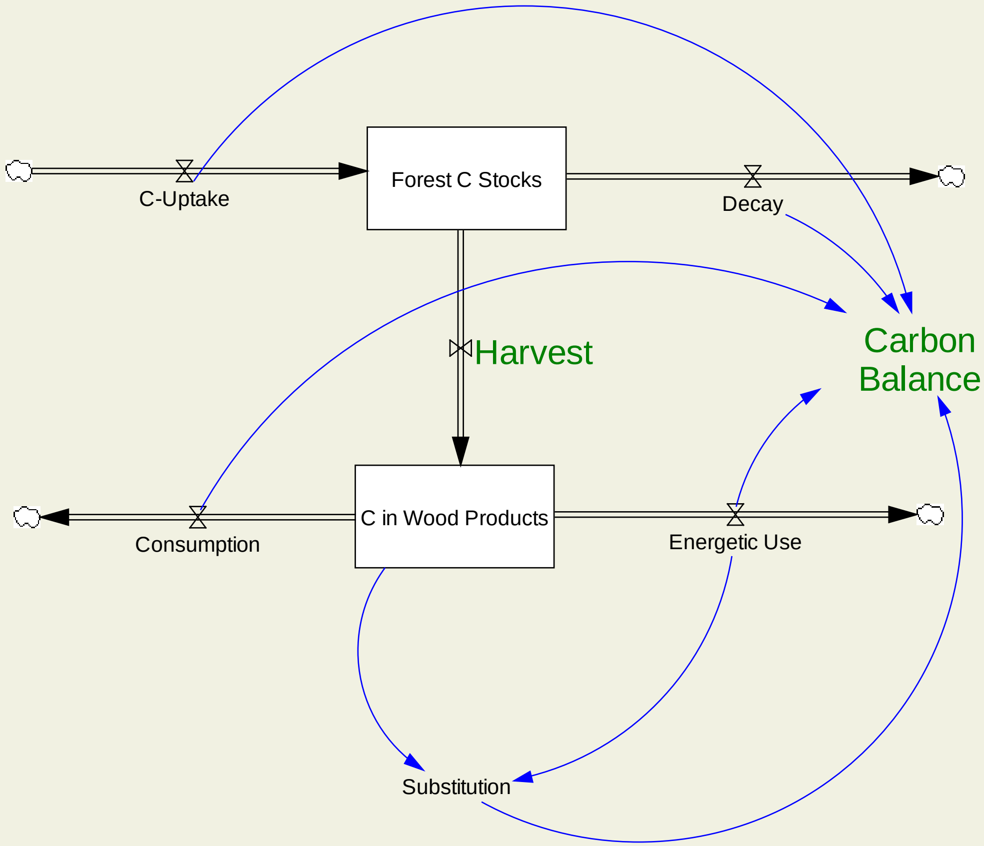
What we also learned

- No CSA under cFMMs develops in a way that totally compromises future provision of desired ES

- However there seems to be potential to increase the provision of several ESs in many case studies

- E.g. sustainable wood provision - most CSAs allow increase on the long run. Do cFMMs not fully cover accelerated growth trends in Europe, yet?

Interactions of Ecosystem Services



- Increased harvest increases C-sequestration only under certain circumstances:

  If wood product stocks and/or substitution effects increase enough, and forest stocks do not shrink too much.

- Hard to predict for real forests without models, esp. for aFMMs

=> **ALTERFOR has something to tell**

Interactions of Ecosystem Services

- **Wood Provision** influences **Regulatory Services** in a complex way. Stand density reduction can increase storm damage risk on the short run but decrease it on the long run.
  The long-run-effect depends on the aFMM in question

- **Biodiversity** and **Regulatory Services**: Transition from even-aged coniferous to uneven-aged mixed forests can reduce fire risk on the long run, but create risky situations for long intermediate time spans.

- **Wood Provision**, **Cultural Services**, **Biodiversity** – similarly complex

Without models, such tradeoffs, synergies cannot be explored for aFMMs in real landscapes

=> Again, ALTERFOR has something to tell

Summary

- **D3.2 documents European state of the art in forest landscape modelling** – from large scale climate down to local silviculture and stakeholder interests. From wood provision to a broad range of services
- Definite potential for improving ES provision (ESP) with aFMMs, but …
- … tradeoffs, synergies of ESP in space and time are too complex to be explored by other means than simulating scenarios
- After D3.2 is before D3.4