



Hybrid Sweetgum in the Southeastern United States

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SRWC Working Group, Seattle WA USA



UK Department of Energy and Climate Change

2020 Targets

- 25% of renewables as biomass
- 50,000,000 dry tonnes biomass total
- 30,000,000 dry tonnes biomass imported
 - 22 million tonnes wood pellets
 - 24-36 wood pellet facilities (1/3 in US South?)
- 20,000,000 dry tonnes biomass-domestic
 - UK Forestry Commission says 2 million tonnes by 2020 in bio-energy forest plantations

• Biomass	2009	2013
	284 MW	1,992 MW

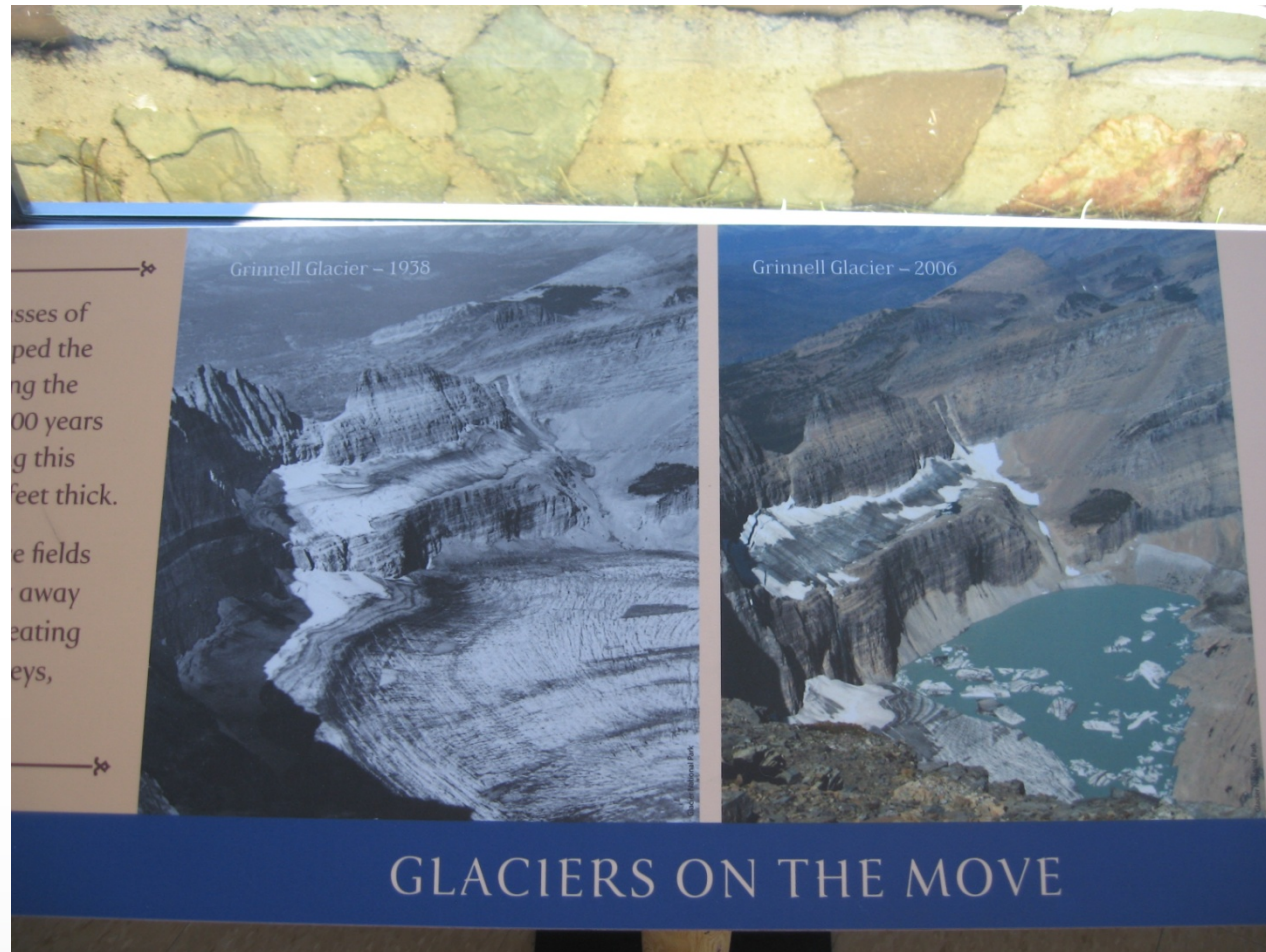
Life Cycle Emissions Including Production

Fuel	CO2 emissions kg/GJ	CO2 emissions kg/MWh
• Hard coal	134	484
• Oil	97	350
• Natural gas	75	270
• Wood chips		
• @ 25% MC	7	25
• Wood pellets		
• @10% MC	9	33

- Source: Biomass Power & Thermal October 2011

Grinnell Glacier 1938 vs. 2006

Climate Change 1 – Glacier National Park 0



Wood Bio-energy South

Projected Annual Wood Demand 2024

www.forisk.com May, 2014

• State	Projects	New Tons*	Current PW Tons*	Harvest Residues**
•				
• AL	8	4,947,460	22,319,461	5,100,000
• AR	7	1,820,000	8,599,960	
• FL	18	10,574,125	8,810,364	4,700,00
• GA	36	18,167,578	24,910,968	
• LA	4	3,300,000	13,202,538	
• MS	8	3,183,239	9,756,782	3,320,000
• NC	13	2,796,000	6,516,913	3,617,000
• SC	11	2,939,800	11,754,290	3,700,000
• TN	6	3,150,000	N/A	
• TX	9	2,862,440	8,828,168	
• VA	15	2,207,300	N/A	
Total	159	68,357,678	125,294,759	
Viability Screened	90	41,835,930		

- *Green tons
- **Green tons estimated as available by state agency or USFS

US South – Pellet Wood Demand (1)

	Roundwood (million tons/year)
2013	3.6
2014-15	11 (under construction)
2015-16	10 (announced)

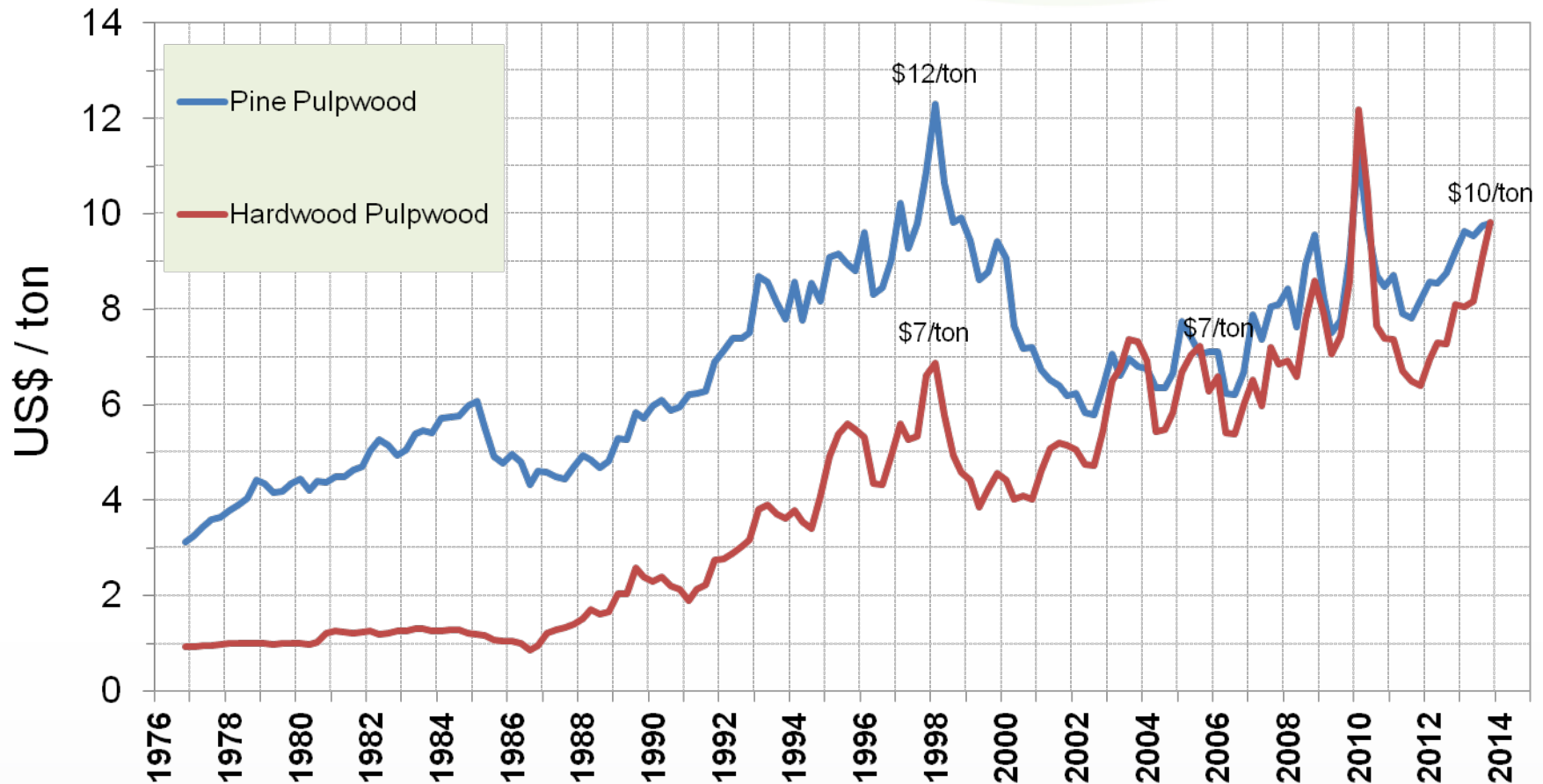
New demand 2013-2016 is 24.6 million tons/year

(1) RISI Wood Biomass Market Report, January 2014

South-wide Pulpwood Stumpage Price Convergence



4th Quarter 1976 – 4th Quarter 2013



Source: Timber Mart-South

Eastern US Hardwood Forest Plantation Opportunities



Sweetgum

Large SG germplasm pool In the USA



Uses: Hardwood pulp, lumber and biomass for energy

Species: *Liquidambar styraciflua*

Site: SE USA –Similar to loblolly

Soils: Poorly to well drained soils
SG is the native hardwood with the broadest deployment potential in the SE USA.

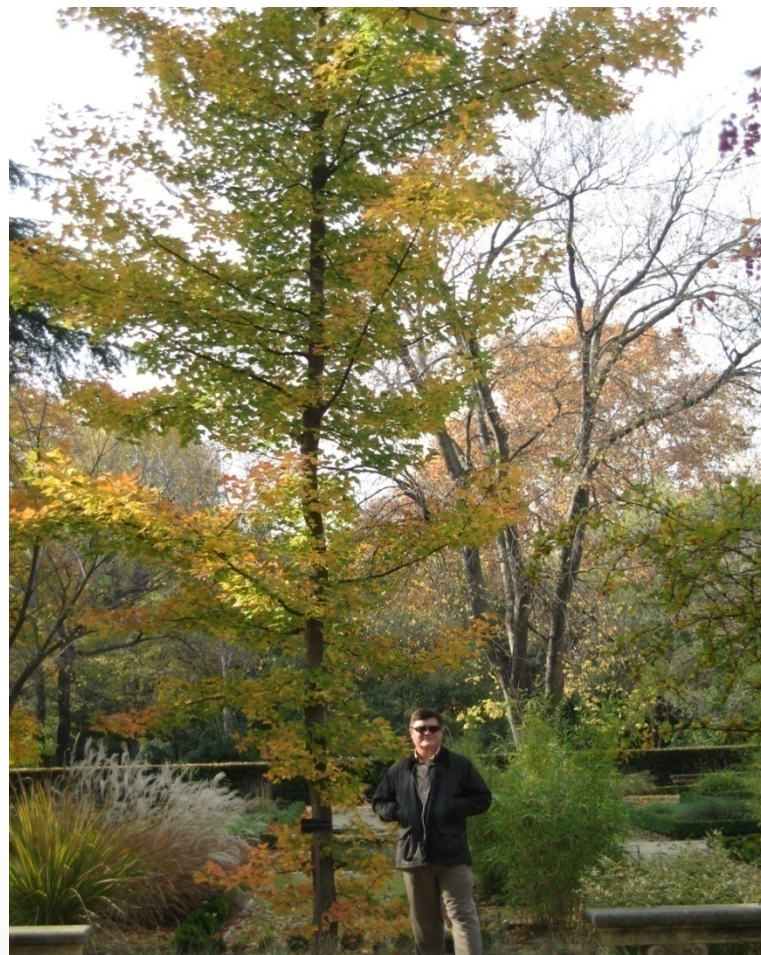
Productivity range: 6-10 Gtons/ac/yr

-Silvicultural regimes for establishing and growing SG are well understood and practical

Improvements: Hybrids with Asian SG

14-year-old Sweetgum plantation Berkeley County, SC—9Gtons/ac/yr

L. styracaflua X *L. formosana*



Hybrid sweetgum

- ArborGen, IPCo and University of Georgia have co-developed a set of more than 50 hybrid sweetgum varieties.
- We have identified 4 of these hybrids that demonstrate superior growth and are of immediate commercial interest
- ArborGen is continuing product development activities including
 - Development of commercial propagation systems
 - Field testing of an additional set of hybrid varieties
 - Development of new hybrids
 - Wood testing
- Propagation work has been very encouraging and we should be to commercial scale production within 3 years.

Production Steps

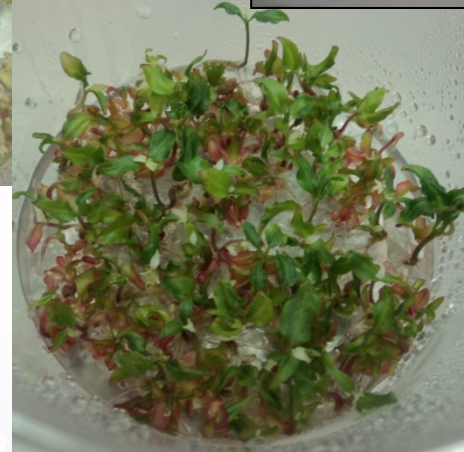
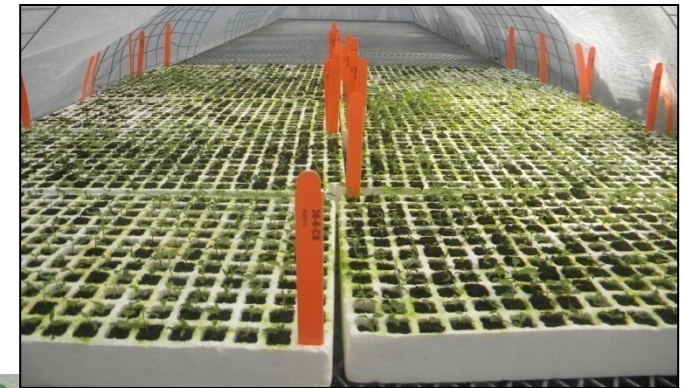
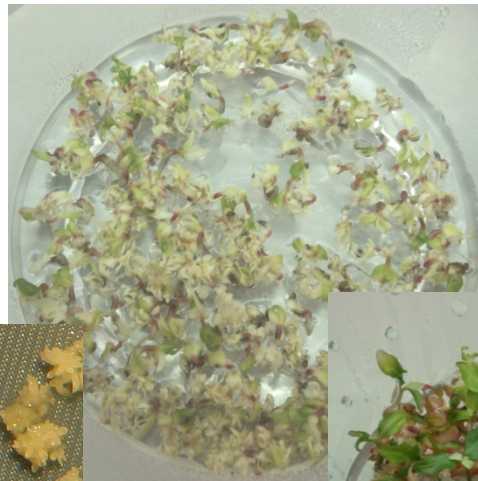
- SE Seedling Production
- Hedge Stock Establishment
- Hedge Stock Maintenance
- Cutting Collection and Setting
- Rooting of Cuttings
- Planting Stock Finishing
- Packing For Delivery
- Field Planting



S3rd Crop Pots

SE Seedling Production

- Cells are singulated and dispersed on plates.
- Embryos develop from cells.
- Embryos germinate and are transplanted to plugs.



S3rd Crop Photo

Hybrid Sweetgum, Age 12 Years, near Augusta GA



Hybrid	DBH 10.9", Height 69'
Conventional	DBH 7.3", Height 59', MAI 12.1 green tons/acre/year

Hedge Stock Maintenance

- Periodic manual pruning required to maintain low hedge profile without sacrificing emerging new shoots.
- Hedges were mechanically sheared to 6" height on monthly schedule at end of season.



Manual clipping after each cutting harvest to remove remaining stubs.



August pruning to 6 inches.

Hedge Stock Establishment

- Hedge stock were grown in both 3-gal pots and 10 ft beds.
- 3 hedge plants established per pot.
- 100 hedge plants established per bed.



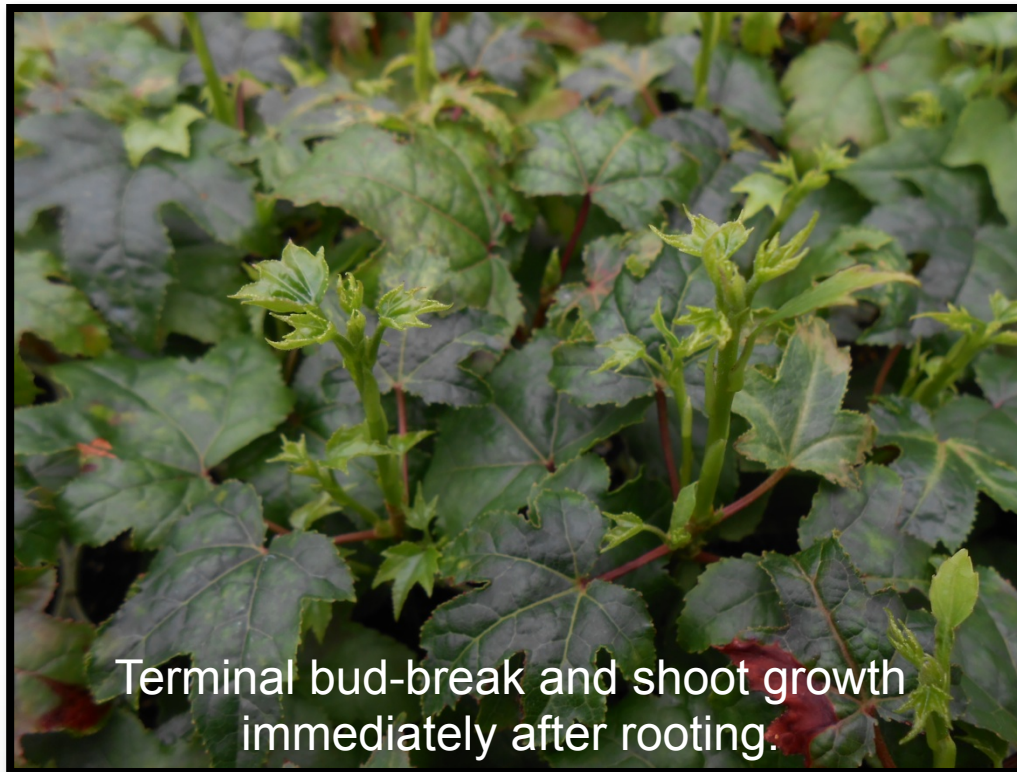
Cutting Collection and Setting

- All cuttings were dipped in fungicide prior to setting.
- Cuttings were set in Leach cells at full density.



Rooting Cuttings

- Rooted cuttings tended to break bud quickly and begin to grow immediately upon removal from mist.
- Root systems were well developed, with several well distributed primary roots and a good proportion of fine roots.



Rooting Cuttings

- Set cuttings were placed under mist for 5 weeks, then 1 week of shade before moving to full sun in the greenhouse.



Cuttings Under
Mist

Hybrid Sweetgum 2008 Trials

- Single Tree Plot Replicated Trials
- Four Sites
 - Jefferson TX
 - Hughes Springs TX
 - Centreville AL
 - Eastover SC

Age 6 Year Actual and Age 14 Year Predicted Growth, near Aiken SC.

	TPA		Height (ft)		DBH (in)		MAI (green tons/ac/yr)		Vol./acre (green tons)
	Age 6	14	Age 6	14	Age 6	14	Age 6	14	Age 14
55-12	510	441	35	72	4.9	8.5	6.7	12.7	178
55-18	510	448	33	68	4.5	8.3	5.4	11.8	165
19-2	510	447	33	68	4.5	8.3	5.5	11.9	166
Check	510	467	26	57	3.5	7.5	3.0	9.0	125

Seedling check lot from rogued seed orchard.

Age 14 predicted values from ArborGen proprietary G&Y model.

Age 6 Year Actual and Age 14 Year Predicted Growth, near Bamberg SC.

	TPA		Height (ft)		DBH (in)		MAI (green tons/ac/yr)		Vol./acre (green tons)
	Age 6	14	Age 6	14	Age 6	14	Age 6	14	Age 14
55-12	726	605	35	77	3.9	7.2	7.8	13.2	185
55-18	726	605	35	77	3.8	7.2	7.8	13.3	186
19-2	726	606	35	76	4.3	7.2	7.4	13.1	183
Check(1)									

(1)Seedling check lot not planted in this trial.

Age 14 predicted values from ArborGen proprietary G&Y model.

Hybrid Sweetgum, Age 6 Years, Bamberg SC



Coppice, Age Five Years After Initial Harvest



Hybrid Sweetgum 2014 Trials

- Ten new hybrid sweetgum clones
- Three current commercial clones (19-2, 55-12, 55-18)
- Block plots and single tree plot trials
- Three sites:
 - Selma AL
 - Eastover SC
 - Texarkana TX

Tree-Type Field Trials

- 21 combinations of treatment factors were tested, but not all combinations of factors were available.
- Two Test Sites (SC, TX)

Treatment Factor	Factor Option 1	Factor Option 2	Factor Option 3
Clone	19-2	55-12	55-18
Propagule Type	RC	SE	OP Seedling
Tree Height	10"	20"	30"
Top-Clip Status	Un-Clipped	Clipped	
Container Type	Super Leach Cell	Stubby Leach Cell	
Exposure to Freeze	Protected	Frozen	
Year Propagated	Current Year	Carryover from 2012	
Age of Hedge Origin	Current Year	1-year-old	

S3rd Crop Pots

HSG BLVs

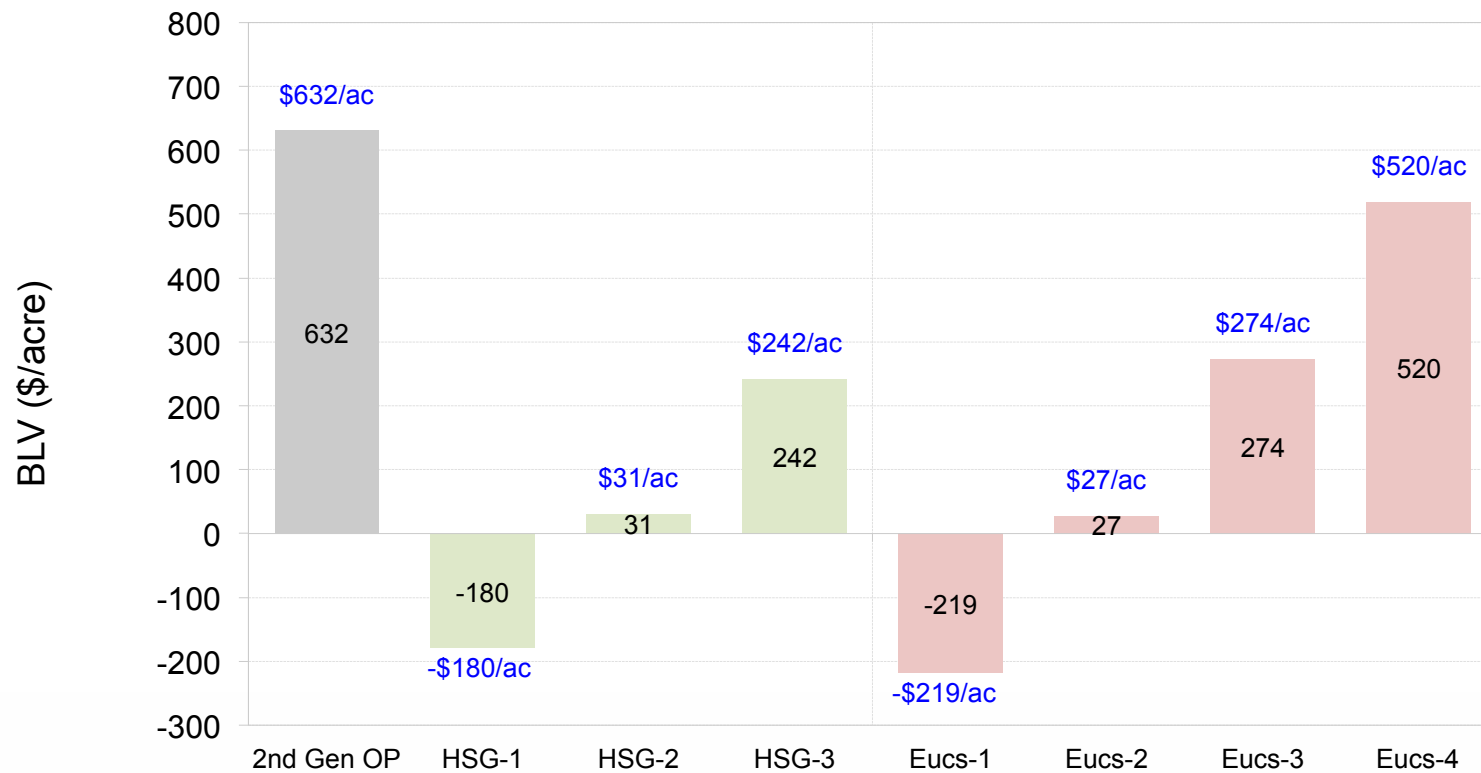
Varying stumpage prices and yield

Target BLV	Stumpage ↓	MAI: tons/ac/yr →							
\$632/ac		8	9	10	11	12	13	14	15
Stumpage	10	-163	-55	53	160	268	376	483	591
\$/ton →	11	-76	42	160	279	397	516	634	752
	12	10	139	268	397	526	655	785	914
	13	96	236	376	516	655	795	935	1,075
	14	182	333	483	634	785	935	1,086	1,237
	15	268	429	591	752	914	1,075	1,237	1,398
	16	354	526	699	871	1,043	1,215	1,387	1,560
	17	440	623	806	989	1,172	1,355	1,538	1,721
	18	526	720	914	1,107	1,301	1,495	1,689	1,882
	19	612	817	1,021	1,226	1,430	1,635	1,839	2,044
	20	699	914	1,129	1,344	1,560	1,775	1,990	2,205

Holding constant first harvest ages

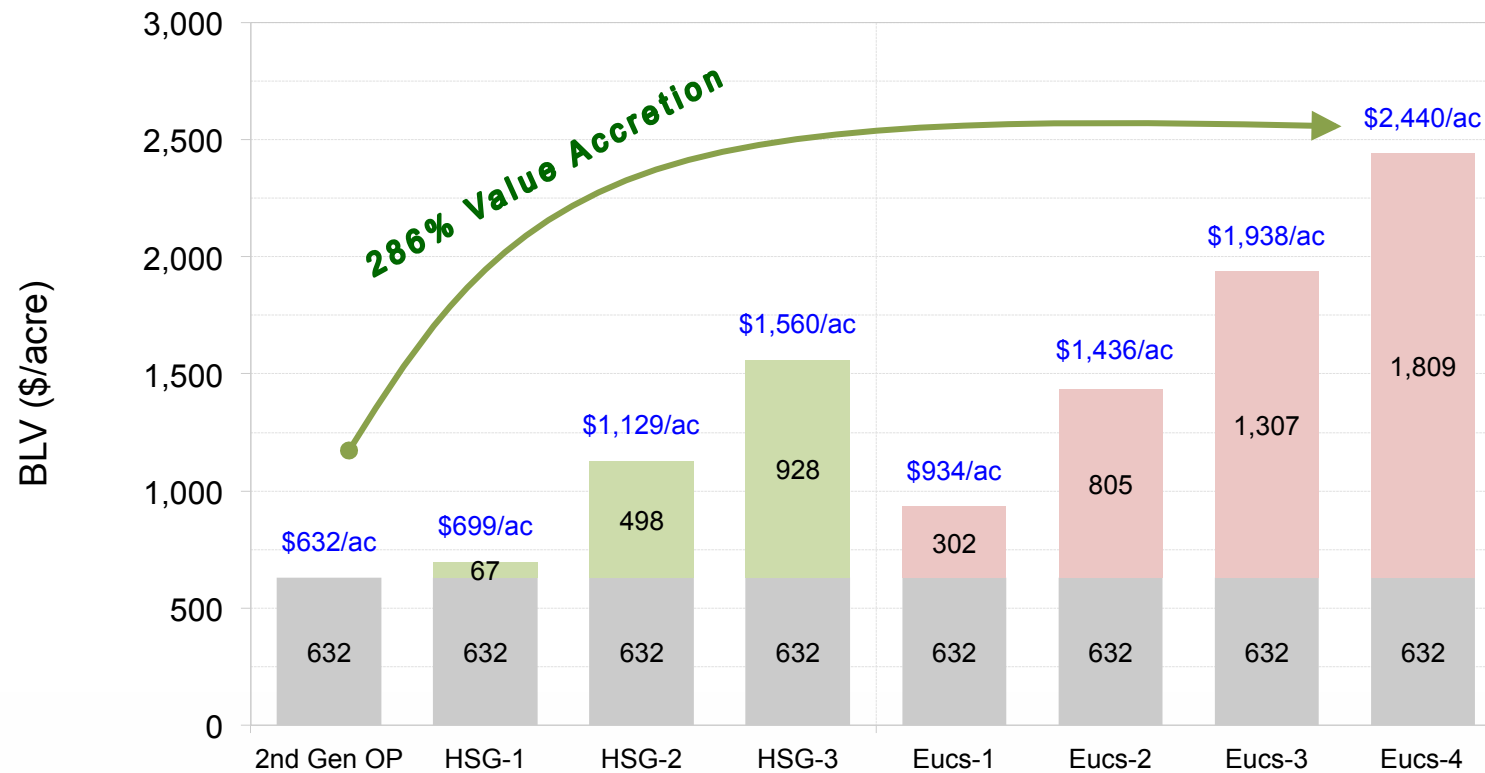
BLV for HSG and Eucs Plantations over Pine

Hardwood stumpage price: \$9.8/ton



BLV for HSG and Eucs Plantations over Pine

Hardwood stumpage price: \$20.0/ton



Questions?

