Woody Biomass Supply and Forest Resource Issues

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Southern Alliance for Clean Energy
TVA Integrated Resource Plan – Stakeholder Review
Woody Biomass Supply

Overview of Project

- Contracted by Southern Alliance for Clean Energy (SACE) to review TVA IRP in regard to woody biomass supply and provide additional supply data.
- **Documents Reviewed**
  - Integrated Resource Plan – TVA's Environmental & Energy Future Draft 1 September 2010 (TVA-IRP)
  - Integrated Resource Plan TVA's Environmental & Energy Future Environmental Impact Statement Draft 1 September 2010 (TVA-EIS)
- **L&M Estimated Woody Biomass Inventory and Supply for Micro Supply Regions for Selected TVA co-fire plants**
  - Mill locations provided by SACE
  - 50 mile procurement radius established using ESRI ArcInfo
  - Data Source – USFS FIA Database Version 4.0 and Various FIA Annual Surveys
    - USFS dry weight of individual tree components using component ratio method
    - Excludes all public lands and stands older than 80 years
    - Derived from FIA Survey Unit Level Inventories
- **L&M Estimated Urban Waste Wood Supply**
  - Geospatial analysis cities in TVA supply area for potential supply

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L&M Estimated Woody Biomass Inventory
Data Source

- Excludes mill residues because markets already exist for this resource.
- Includes Logging Residues and Small Size Roundwood Inventory
  - Derived from USFS FIA NIMS data which reflects average age of 2005
  - Reported in Dry Tons based USFS FIA dry weight of individual tree components (stemwood, top, branches, bark, stump and coarse roots) using component ratio method (CRM) as described in Appendix J Biomass Estimation in the FIADB-Database Description and Users Manual
  - Biomass Supply Buckets based on current timber market specifications
  - Excludes public lands and stands over 80 years

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L&M Estimated Woody Biomass Supply
Biomass Database Fields/Calculations

Database Fields - Acres and Dry Tons
- Management Type – Planted Pine, Natural Pine, Pine/Hardwood, Upland Hardwood, Bottomland Hardwood
- Age Class – Five Year
- Damaged Class – 1 – Significant 25% trees affected 0 – No Significance
- Diameter class – Tons only

Database Volume Calculations
- **Mervolsum**-sum of net merchantable volume in cubic feet (1 foot stump to 4 inch top bole diameter). This is the traditional FIA volume variable.
- **Sawcfsum**-sum of net volume of saw-log section in cubic feet. This is a subset of Mervolsum. Only populated for growing stock trees of sawtimber size.
- **Bolewtsum**-sum of dry weight of the merchantable bole in tons.
- **Sawwtsum-**sum of dry weight of the saw-log section in tons.
- **Upstemwtsum**-sum of dry weight (tons) in the upper stem (saw-log top to 4.0 inch bole diameter) of sawtimber trees.
- **Stumpwtsum**-sum of dry weight (tons) in the stump (ground level to 1.0 foot above ground) of trees 5.0 inches d.b.h. and larger.
- **Topwtsum**--sum of dry weight (tons) in the top of trees 5.0 inches d.b.h. and larger. Includes bole from 4.0 inch top diameter to tip and all branches. Does not include foliage.
- **Sapwtsum**--sum of dry weight (tons) of trees 1.0--4.9 inches d.b.h.
- **Understory**- dry weight (tons) of understory components (seedlings, shrubs, brush) above ground. Derived from Carbon_understory_AG variable

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L&M Estimated Woody Biomass Supply

Biomass Supply Buckets

Tree and Stand Components

- **Slash & Brush -** Under utilized and Non-Commercial species
- **Logging Residue** - Tops, Branches, Stumps and Unused bole of merchantable trees, Saplings – total tree weight
- **Pulpwood Tree Volume** – The portion of live trees 5.0 inches DBH and above not allocated to sawlog section of the tree
- **Small Sawtimber Tree Volume** – The sawlog section of live trees 10-12 DBH only
- **Salvage from Fire, Insect & Disease** - All tree volume associated with damaged stands
- **Pre-Merchantable** – Stands 0-10 Years
- **Merchantable** – Stands >10 Years

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L&M Estimated Urban Wood Waste

Assumptions

- 2007 Census Population
- Urban Wood Waste = Large Diameter Wood Generated by Tree Servicing Companies
- Availability Factor – 60% Source Carter etal. 2007
- Yield - .203 Green Tons/Capita/Year – Source Wiltsee 1998
- Dry Tons = .5*Green Tons
- All Cities within Procurement Radius

Results for Total Supply for TVA Coal Plants

- Large Cities >90,000 population – 118,150 Dry Tons
- Medium Cities 25,000<>90,000 population – 40,192 Dry Tons
- Small Cities <25,000 population – 127,011 Dry Tons

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L&M Estimation of Annual Biomass Supply

- Biomass inventory restricted for utilization constraints and possible environmental considerations
- Annual growth and removal projections for pulpwood and sawtimber derived from 2010 SOFAC SRTS (Subregional Timber Supply Model) Southwide V23 Demand Run
- Projections represent historical timber removals and growth including land use changes
- Derived annual % growth of inventory and % removal inventory for pulpwood and sawtimber
- % Growth minus % Removal = Estimated available annual supply %

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Woody Biomass Supply

L&M Analysis of Annual Biomass Supply by TVA Coal Plant 50 Mile Procurement

- Compared estimated annual demand for 50 MW Co-Fire plant to each 50 mile procurement radius
- Considering only the traditional biomass supply buckets (damage volume, slash & brush and logging residuals), six procurement areas have greater Annual Biomass Supply than Annual Biomass Demand
  - Shawnee
  - John Sevier
  - Paradise
  - Willows Creek
  - Cumberland
  - Gallatin
- Note Annual Biomass Supply estimates do not reflect cost feasibility, only supply
- Also, Annual Biomass Supply estimates do not reflect any management options for increasing future supply in roundwood supply buckets

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Estimated Total Woody Biomass Inventory (Dry Tons) Within 50 Mile Procurement Radius - Overlapping

Total Dry Tons - Detail and Summary (1) (2)

Supply Bucket	Total TVA Supply Area	Shawnee	Allen	John Seveir	Johnsonville	Paradise	Widows Creek	Colbert	Bull Run	Cumberland	Gallatin	Kingston
Salvage from Damaged Stands (7) (8 & 9)	80,930,487	7,771,246	1,527,029	9,720,445	5,778,625	6,035,583	6,114,511	3,369,551	10,686,068	6,987,238	3,302,632	11,421,617
Slash & Brush (3) (8) (9)	67,860,213	1,742,658	2,273,513	4,640,864	6,167,437	4,165,627	5,455,270	5,933,360	4,944,144	5,719,087	4,798,378	5,293,555
Tops, Limbs, Stumps Merchantable (4) (9)	350,697,072	9,818,348	11,244,859	29,655,000	35,592,881	24,923,669	29,567,209	27,874,112	30,419,373	33,572,110	29,368,206	32,377,821
Tops, Limbs, Stumps Pre-merchantable (4) (8)	19,026,890	88,256	648,007	872,464	1,274,101	136,914	1,678,051	2,067,357	1,121,524	832,344	248,069	1,178,761
Pulpwood from Premerchantable Stands (5) (8)	12,311,200	59,391	478,538	618,401	724,541	105,963	1,074,656	1,346,037	741,042	479,005	167,674	748,995
Pulpwood Inventory from Merchantable Stands (5) (9)	393,919,992	11,339,830	12,221,083	33,054,480	41,196,770	28,186,171	33,456,609	30,889,301	34,226,898	39,045,179	35,177,350	36,785,236
Small Sawtimber Inventory (6) (8 & 9)	461,228,907	13,236,472	15,620,241	43,774,818	46,118,007	33,590,200	39,365,109	35,209,537	44,308,278	43,162,312	36,607,305	46,746,925
Total	1,385,974,762	44,056,201	44,013,270	122,336,471	136,852,362	97,144,127	116,711,415	106,689,256	126,447,328	129,797,275	109,669,615	134,552,910

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Estimated Woody Biomass Dry Tons Inventory Within 50 Mile Procurement Radius - Not Overlapping

Total Dry Tons - Detail and Summary (1) (2)

Supply Bucket	Total TVA Supply Area	Shawnee	Allen	John Seveir	Johnsonville	Paradise	Widows Creek	Colbert	Bull Run	Cumberland	Gallatin	Kingston
Salvage from Damaged Stands (7) (8 & 9)	80,930,487	8,393,720	1,527,029	8,705,063	2,869,004	5,865,452	6,114,511	3,086,398	5,801,274	3,640,922	2,173,366	7,838,735
Slash & Brush (3) (8) (9)	67,860,213	1,633,414	2,273,513	4,042,377	4,476,328	4,049,009	5,455,270	5,649,354	2,656,574	2,504,219	4,093,532	3,697,175
Tops, Limbs, Stumps Merchantable (4) (9)	350,697,072	9,273,434	11,244,859	25,754,988	25,425,244	24,152,894	29,567,209	26,637,782	16,301,178	14,975,307	25,172,120	22,408,265
Tops, Limbs, Stumps Pre-merchantable (4) (8)	19,026,890	24,139	648,007	807,049	1,146,035	130,264	1,678,051	1,960,881	604,670	248,628	197,258	826,102
Pulpwood from Premerchantable Stands (5) (8)	12,311,200	18,496	478,538	569,285	651,745	105,469	1,074,656	1,309,819	402,747	141,515	135,398	508,962
Pulpwood Inventory from Merchantable Stands (5) (9)	393,919,992	10,692,118	12,221,083	28,793,032	29,133,634	27,195,017	33,456,609	29,477,397	18,285,310	17,637,673	30,427,811	25,620,779
Small Sawtimber Inventory (6) (8 & 9)	461,228,907	12,395,731	15,620,241	38,121,359	33,528,600	32,882,521	39,365,109	33,625,835	23,747,170	18,754,698	30,857,308	32,021,553
Total	1,385,974,762	42,431,053	44,013,270	106,793,153	97,230,592	94,380,627	116,711,415	101,747,468	67,798,923	57,902,961	93,056,793	92,921,571

Based on the following customized query of FIA Database March 2010

(1) USFS FIA dry weight of individual tree components (stemwood, top, branches, bark, stump and coarse roots) using component ratio method (CRM) as described in Appendix J Biomass Estimation in the FIADB - FIA Database description and Users Manual for Phase 2, Version 4.0, revision 2, December 2009, Utilizes a compiled set of specie and bark specific gravities to adjust green weight volumes. For smaller trees (saplings and woodland species), only a total biomass value representing wood and bark from ground to tip excluding foliage is available.

(2) Exclude all public lands and timber acres older than 80 years

(3) Understory_bio_sum--estimated biomass (in Tons) of understory components (seedlings, shrubs, brush) aboveground. Derived from Carbon_understory_AG variable, which is in tons/acre in Condition table of FIADB 4.0. This variable is estimated from models based on region, forest type and live tree carbon density (Smith and Health 2008). Understory biomass values at the population level were computed as follows: Understory_bio = Carbon_understory_AG * 2 * Condition Acres

(4) Logging Residue - Tops, Branches and Unused bole of merchantable trees based on following formulas
Upstemwtsum-sum of dry weight (tons) in the upper stem (saw-log top to 4.0 inch bole diameter) of sawtimber trees.
Stumpwtsum-sum of dry weight (tons) in the stump (ground level to 1.0 foot above ground) of trees 5.0 inches d.b.h. and larger.
Topwtsum--sum of dry weight (tons) in the top of trees 5.0 inches d.b.h. and larger. Includes bole from 4.0 inch top diameter to tip and all branches. Does not include foliage.

(5) Pulpwood Tree Volume - The portion of live trees 5.0 inches DBH and above not allocated to saw-log section of the tree based on following formula
Bolewtsum-sum of dry weight of the merchantable bole in tons.

(6) Small Sawtimber Tree Volume - The saw-log section of live trees < 13 DBH based on following formula
Sawwtsum-sum of dry weight of the saw-log section in tons.

(7) Salvage from Fire, Insect & Disease - All tree volume associated with damaged stands based on FIA Formulas Upstemwtsum, Stumpwtsum, Topwtsum, Bolewtsum

(8) Pre-Merchantable - Stands 0-10 Years

(9) Merchantable -Stands >10 Years and <80 years

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Estimated Total Woody Biomass Inventory (Dry Tons) Within 50 Mile Procurement Radius - Overlapping
Restricted for Utilization Limits and Possible Environmental Considerations

Total Dry Tons - Detail and Summary (1) (2) - Restricted for Utilization Assumptions (10)

Supply Bucket	Total TVA Supply Area	Shawnee	Allen	John Seveir	Johnsonville	Paradise	Widows Creek	Colbert	Bull Run	Cumberland	Gallatin	Kingston
Salvage from Damaged Stands (7) (8 & 9)	20,232,622	1,942,811	381,757	2,430,111	1,444,656	1,508,896	1,528,628	842,388	2,671,517	1,746,809	825,658	2,855,404
Slash & Brush (3) (8) (9)	33,930,107	871,329	1,136,756	2,320,432	3,083,719	2,082,813	2,727,635	2,966,680	2,472,072	2,859,544	2,399,189	2,646,778
Tops, Limbs, Stumps Merchantable (4) (9)	210,418,243	5,891,009	6,746,915	17,793,000	21,355,729	14,954,202	17,740,325	16,724,467	18,251,624	20,143,266	17,620,923	19,426,692
Tops, Limbs, Stumps Pre-merchantable (4) (8)	11,416,134	52,954	388,804	523,478	764,461	82,148	1,006,831	1,240,414	672,915	499,406	148,841	707,256
Pulpwood from Premerchantable Stands (5) (8)	9,233,400	44,543	358,904	463,801	543,406	79,473	805,992	1,009,528	555,782	359,254	125,756	561,747
Pulpwood Inventory from Merchantable Stands (5) (9)	118,175,998	3,401,949	3,666,325	9,916,344	12,359,031	8,455,851	10,036,983	9,266,790	10,268,069	11,713,554	10,553,205	11,035,571
Small Sawtimber Inventory (6) (8 & 9)	138,368,672	3,970,942	4,686,072	13,132,445	13,835,402	10,077,060	11,809,533	10,562,861	13,292,483	12,948,694	10,982,192	14,024,077
Total	541,775,175	16,175,537	17,365,534	46,579,611	53,386,403	37,240,443	45,655,926	42,613,129	48,184,462	50,270,527	42,655,764	51,257,526

Based on the following customized query of FIA Database March 2010

(1) USFS FIA dry weight of individual tree components (stemwood, top, branches, bark, stump and coarse roots) using component ratio method (CRM) as described in Appendix J Biomass Estimation in the FIADB - FIA Database description and Users Manual for Phase 2, Version 4.0, revision 2, December 2009, Utilizes a compiled set of specie and bark specific gravities to adjust green weight volumes. For smaller trees (saplings and woodland species), only a total biomass value representing wood and bark from ground to tip excluding foliage is available.

(2) Exclude all public lands and timber acres older than 80 years

(3) Understory_bio_sum--estimated biomass (in Tons) of understory components (seedlings, shrubs, brush) aboveground. Derived from Carbon_understory_AG variable, which is in tons/acre in Condition table of FIADB 4.0. This variable is estimated from models based on region, forest type and live tree carbon density (Smith and Health 2008). Understory biomass values at the population level were computed as follows: Understory_bio = Carbon_understory_AG * 2 * Condition Acres

(4) Logging Residue - Tops, Branches and Unused bole of merchantable trees based on following formulas
Upstemwtsum-sum of dry weight (tons) in the upper stem (saw-log top to 4.0 inch bole diameter) of sawtimber trees.
Stumpwtsum-sum of dry weight (tons) in the stump (ground level to 1.0 foot above ground) of trees 5.0 inches d.b.h. and larger.
Topwtsum--sum of dry weight (tons) in the top of trees 5.0 inches d.b.h. and larger. Includes bole from 4.0 inch top diameter to tip and all branches. Does not include foliage.

(5) Pulpwood Tree Volume - The portion of live trees 5.0 inches DBH and above not allocated to saw-log section of the tree based on following formula
Bolewtsum-sum of dry weight of the merchantable bole in tons.

(6) Small Sawtimber Tree Volume - The saw-log section of live trees < 13 DBH based on following formula
Sawwtsum-sum of dry weight of the saw-log section in tons.

(7) Salvage from Fire, Insect & Disease - All tree volume associated with damaged stands based on FIA Formulas Upstemwtsum, Stumpwtsum, Topwtsum, Bolewtsum

(8) Pre-Merchantable - Stands 0-10 Years

(9) Merchantable -Stands >10 Years and <80 years

(10) Utilization Rates - share of each supply bucket that might be captured or utilized based on technical constraints, source Abt/Seawell 2010 and Mulkey 2010

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Estimated Woody Biomass Dry Tons Within 50 Mile Procurement Radius WITHOUT Overlapping Supply
Restricted for Utilization Limits and Possible Environmental Considerations

Total Dry Tons - Detail and Summary (1) (2) - Restricted for Utilization Assumptions (10)

Supply Bucket	Total TVA Supply Area	Shawnee	Allen	John Seveir	Johnsonville	Paradise	Widows Creek	Colbert	Bull Run	Cumberland	Gallatin	Kingston
Salvage from Damaged Stands (7) (8 & 9)	20,232,622	2,098,430	381,757	2,176,266	717,251	1,466,363	1,528,628	771,600	1,450,318	910,231	543,342	1,959,684
Slash & Brush (3) (8) (9)	33,930,107	816,707	1,136,756	2,021,188	2,238,164	2,024,505	2,727,635	2,824,677	1,328,287	1,252,109	2,046,766	1,848,588
Tops, Limbs, Stumps Merchantable (4) (9)	210,418,243	5,564,061	6,746,915	15,452,993	15,255,147	14,491,737	17,740,325	15,982,669	9,780,707	8,985,184	15,103,272	13,444,959
Tops, Limbs, Stumps Pre-merchantable (4) (8)	11,416,134	14,484	388,804	484,230	687,621	78,159	1,006,831	1,176,529	362,802	149,177	118,355	495,661
Pulpwood from Premerchantable Stands (5) (8)	9,233,400	13,872	358,904	426,964	488,809	79,101	805,992	982,364	302,060	106,136	101,548	381,721
Pulpwood Inventory from Merchantable Stands (5) (9)	118,175,998	3,207,636	3,666,325	8,637,910	8,740,090	8,158,505	10,036,983	8,843,219	5,485,593	5,291,302	9,128,343	7,686,234
Small Sawtimber Inventory (6) (8 & 9)	138,368,672	3,718,719	4,686,072	11,436,408	10,058,580	9,864,756	11,809,533	10,087,750	7,124,151	5,626,409	9,257,193	9,606,466
Total	541,775,175	15,433,908	17,365,534	40,635,957	38,185,662	36,163,126	45,655,926	40,668,809	25,833,919	22,320,548	36,298,818	35,423,312

Based on the following customized query of FIA Database March 2010

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(2) Exclude all public lands and timber acres older than 80 years

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Bolewtsum-sum of dry weight of the merchantable bole in tons.

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(10) Utilization Rates - share of each supply bucket that might be captured or utilized based on technical constraints, source Abt/Seawell 2010 and Mulkey 2010

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Estimated Annual Woody Biomass Dry Tons Within 50 Mile Procurement Radius WITH Overlapping Supply
Based on Subregional Timber Supply Model Projections (SRTS) Surplus Growth (Growth minus Removals) by FIA Unit

Total Dry Tons - Detail and Summary (1) (2) - Restricted for Utilization Assumptions (10)

Supply Bucket	Total TVA Supply Area	Shawnee	Allen	John Seveir	Johnsonville	Paradise	Widows Creek	Colbert	Bull Run	Cumberland	Gallatin	Kingston
Salvage from Damaged Stands (7) (8 & 9)	510,776	75,338	8,769	47,556	(1,957)	65,896	21,242	6,038	30,548	88,425	70,734	23,978
Slash & Brush (3) (8) (9)	856,572	33,788	26,112	45,410	(4,176)	90,960	37,904	21,265	28,267	144,753	205,538	22,226
Logging Residuals Merchantable (4) (9)	5,312,049	228,440	154,982	348,200	(28,922)	653,074	246,522	119,881	208,702	1,019,674	1,509,581	163,135
Logging Residuals Pre-merchantable (4) (8)	288,202	2,053	8,931	10,244	(1,035)	3,588	13,991	8,891	7,695	25,280	12,751	5,939
Pulpwood from Premerchantable Stands (5) (8)	233,099	1,727	8,244	9,076	(736)	3,471	11,200	7,236	6,355	18,186	10,773	4,717
Pulpwood Inventory from Merchantable Stands (5) (9)	2,983,376	131,920	84,218	194,058	(16,738)	369,281	139,475	66,425	117,412	592,953	904,091	92,671
Small Sawtimber Inventory (6) (8 & 9)	3,315,406	253,511	206,655	432,705	286,833	136,736	151,187	244,466	82,744	514,014	415,958	8,177
Est Annual Supply	13,499,481	726,777	497,911	1,087,249	233,269	1,323,005	621,520	474,203	481,724	2,403,286	3,129,426	320,843
Est Annual Demand (11)	2,557,424	280,419	280,419	280,419	280,419	280,419	280,419	280,419	280,419	280,419	280,419	280,419
Demand/Supply	18.94%	38.58%	56.32%	25.79%	120.21%	21.20%	45.12%	59.13%	58.21%	11.67%	8.96%	87.40%

Based on the following customized query of FIA Database March 2010

(1) USFS FIA dry weight of individual tree components (stemwood, top, branches, bark, stump and coarse roots) using component ratio method (CRM) as described in Appendix J Biomass Estimation in the FIADB - FIA Database description and Users Manual for Phase 2, Version 4.0, revision 2, December 2009, Utilizes a compiled set of specie and bark specific gravities to adjust green weight volumes. For smaller trees (saplings and woodland species), only a total biomass value representing wood and bark from ground to tip excluding foliage is available.

(2) Exclude all public lands and timber acres older than 80 years

(3) Understory_bio_sum--estimated biomass (in Tons) of understory components (seedlings, shrubs, brush) aboveground. Derived from Carbon_understory_AG variable, which is in tons/acre in Condition table of FIADB 4.0. This variable is estimated from models based on region, forest type and live tree carbon density (Smith and Health 2008). Understory biomass values at the population level were computed as follows: Understory_bio = Carbon_understory_AG * 2 * Condition Acres

(4) Logging Residue - Tops, Branches and Unused bole of merchantable trees based on following formulas
Upstemwtsum-sum of dry weight (tons) in the upper stem (saw-log top to 4.0 inch bole diameter) of sawtimber trees.
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Topwtsum--sum of dry weight (tons) in the top of trees 5.0 inches d.b.h. and larger. Includes bole from 4.0 inch top diameter to tip and all branches. Does not include foliage.

(5) Pulpwood Tree Volume - The portion of live trees 5.0 inches DBH and above not allocated to saw-log section of the tree based on following formula
Bolewtsum-sum of dry weight of the merchantable bole in tons.

(6) Small Sawtimber Tree Volume - The saw-log section of live trees < 13 DBH based on following formula
Sawwtsum-sum of dry weight of the saw-log section in tons.

(7) Salvage from Fire, Insect & Disease - All tree volume associated with damaged stands based on FIA Formulas Upstemwtsum, Stumpwtsum, Topwtsum, Bolewtsum

(8) Pre-Merchantable - Stands 0-10 Years

(9) Merchantable -Stands >10 Years and <80 years

(10) Utilization Rates - share of each supply bucket that can might captured or utilized based on technical constraints, source Abt/Seawell 2010 and Mulkey 2010

(11) TVA Total Future Production Projections- page 147 TVA-EIS
Single Plant - Co-Fire conversion, 50 MW, 8,600 BTU/LB Green and 13,002 BTU/Kwh
Total TVA -456 MW Total Biomass Demand, 8,600 BTU/LB and 13,002 BTU/Kwh

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TVA Integrated Resource Plan- Stakeholder Review

Estimated Woody Biomass Dry Tons Within 50 Mile Procurement Radius WITHOUT Overlapping Supply
Based on Subregional Timber Supply Model Projections of Surplus Growth (Growth minus Removals) by FIA Unit

Total Dry Tons - Detail and Summary (1) (2) - Restricted for Utilization Assumptions (10)

Supply Bucket	Total TVA Supply Area	Shawnee	Allen	John Seveir	Johnsonville	Paradise	Widows Creek	Colbert	Bull Run	Cumberland	Gallatin	Kingston
Salvage from Damaged Stands (7) (8 & 9)	510,776	71,801	8,275	39,461	11,214	65,894	22,153	6,333	13,771	29,722	42,387	16,349
Slash & Brush (3) (8) (9)	856,572	27,945	24,641	36,649	34,994	90,975	39,529	23,185	12,612	40,886	159,671	15,422
Logging Residuals Merchantable (4) (9)	5,312,049	190,383	146,250	280,200	238,519	651,212	257,092	131,188	92,867	293,400	1,178,228	112,167
Logging Residuals Pre-merchantable (4) (8)	288,202	496	8,428	8,780	10,751	3,512	14,591	9,657	3,445	4,871	9,233	4,135
Pulpwood from Premerchantable Stands (5) (8)	233,099	475	7,780	7,742	7,643	3,555	11,680	8,063	2,868	3,466	7,922	3,185
Pulpwood Inventory from Merchantable Stands (5) (9)	2,983,376	109,754	79,473	156,626	136,654	366,617	145,456	72,586	52,085	172,781	712,115	64,124
Small Sawtimber Inventory (6) (8 & 9)	3,315,406	219,741	201,826	372,285	286,650	171,762	162,838	241,409	54,919	182,336	309,582	43,037
Est Annual Supply	13,499,481	620,596	476,673	901,743	726,427	1,353,527	653,339	492,422	232,567	727,462	2,419,138	258,419
Est Annual Demand (11)	2,557,424	280,419	280,419	280,419	280,419	280,419	280,419	280,419	280,419	280,419	280,419	280,419
Demand/Supply	18.94%	45.19%	58.83%	31.10%	38.60%	20.72%	42.92%	56.95%	120.58%	38.55%	11.59%	108.51%

Based on the following customized query of FIA Database March 2010

(1) USFS FIA dry weight of individual tree components (stemwood, top, branches, bark, stump and coarse roots) using component ratio method (CRM) as described in Appendix J Biomass Estimation in the FIADB - FIA Database description and Users Manual for Phase 2, Version 4.0, revision 2, December 2009, Utilizes a compiled set of specie and bark specific gravities to adjust green weight volumes. For smaller trees (saplings and woodland species), only a total biomass value representing wood and bark from ground to tip excluding foliage is available.

(2) Exclude all public lands and timber acres older than 80 years

(3) Understory_bio_sum--estimated biomass (in Tons) of understory components (seedlings, shrubs, brush) aboveground. Derived from Carbon_understory_AG variable, which is in tons/acre in Condition table of FIADB 4.0. This variable is estimated from models based on region, forest type and live tree carbon density (Smith and Health 2008). Understory biomass values at the population level were computed as follows: Understory_bio = Carbon_understory_AG * 2 * Condition Acres

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(10) Utilization Rates - share of each supply bucket that can might captured or utilized based on technical constraints, source Abt/Seawell 2010 and Mulkey 2010

(11) TVA Total Future Production Projections- page 147 TVA-EIS
Single Plant - Co-Fire conversion, 50 MW, 8,600 BTU/LB Green and 13,002 BTU/Kwh
Total TVA -456 MW Total Biomass Demand, 8,600 BTU/LB and 13,002 BTU/Kwh

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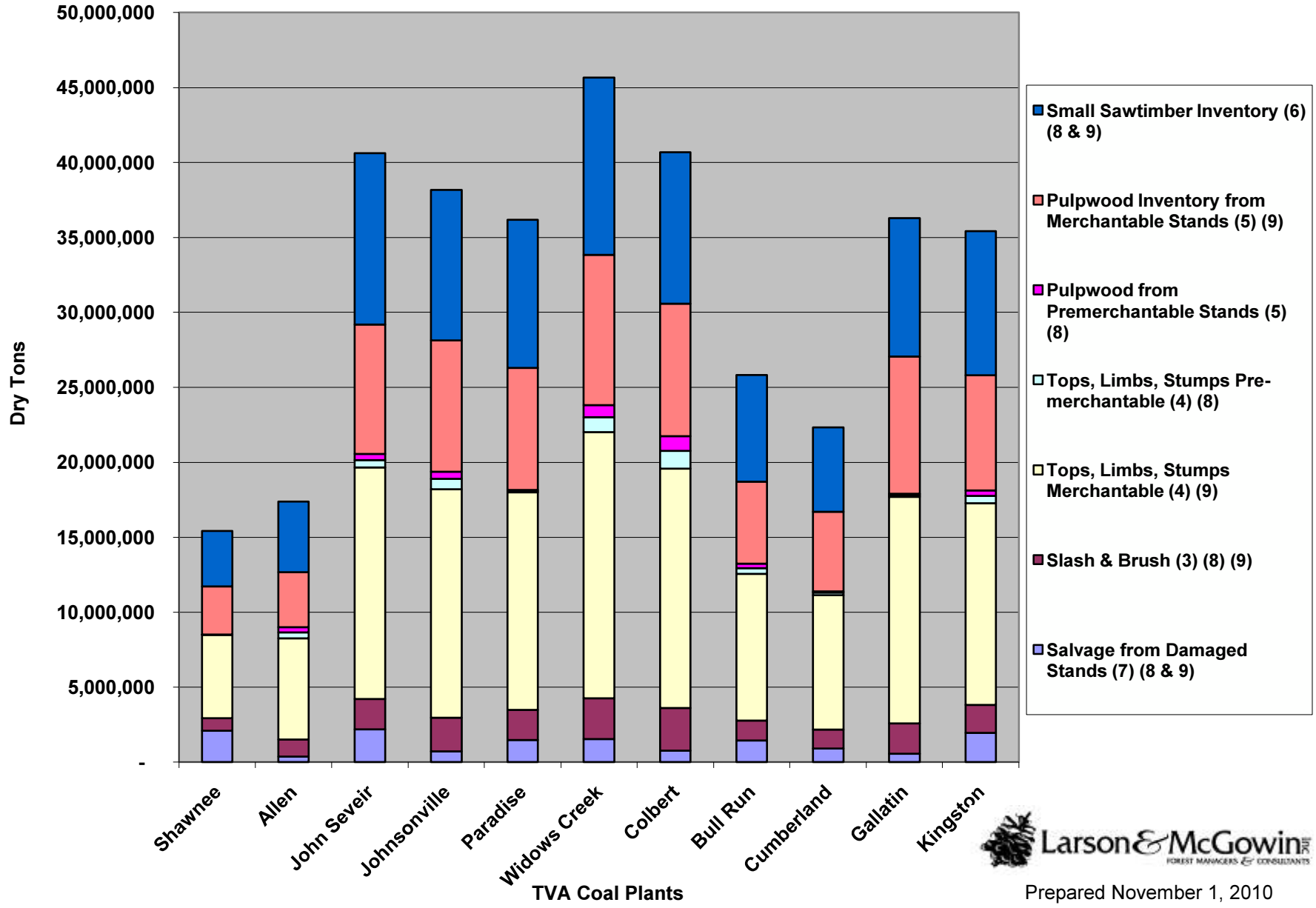
Prepared November 1, 2010

Southern Alliance for Clean Energy (SACE)
TVA Integrated Resource Plan - Stakeholder Review

Estimated Total Woody Biomass Inventory for Non-Overlapping 50 mile Procurement Radius

Source - USFS FIADB Woody Biomass Database including utilization restrictions



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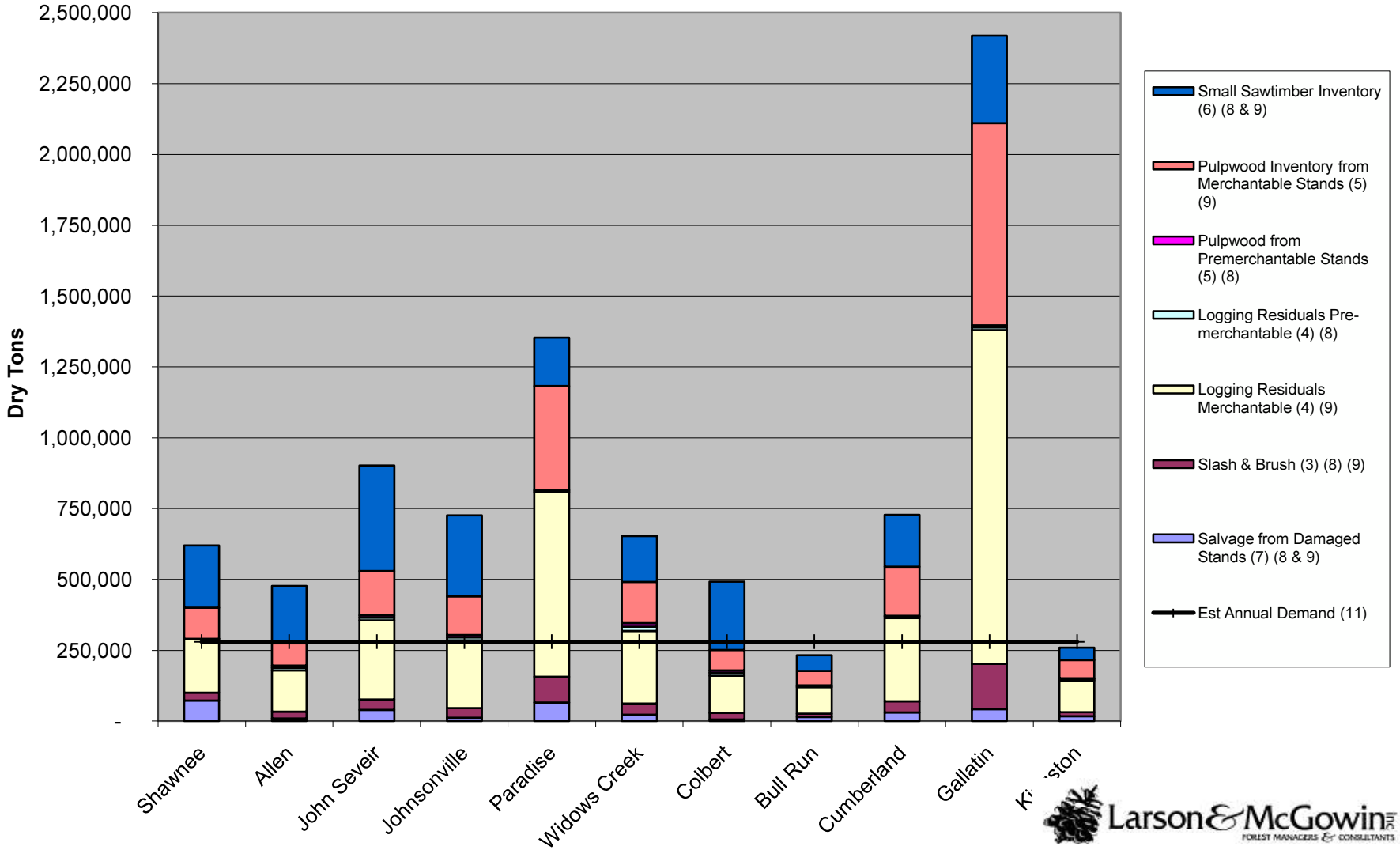
Estimated Annual Woody Biomass Supply for Non-Overlapping 50 mile Procurement Radius
Source - USFS FIADB including utilization restrictions
Based on Subregional Timber Supply Model (SRTS) Projections of Weighted Average Surplus Growth by FIA Unit



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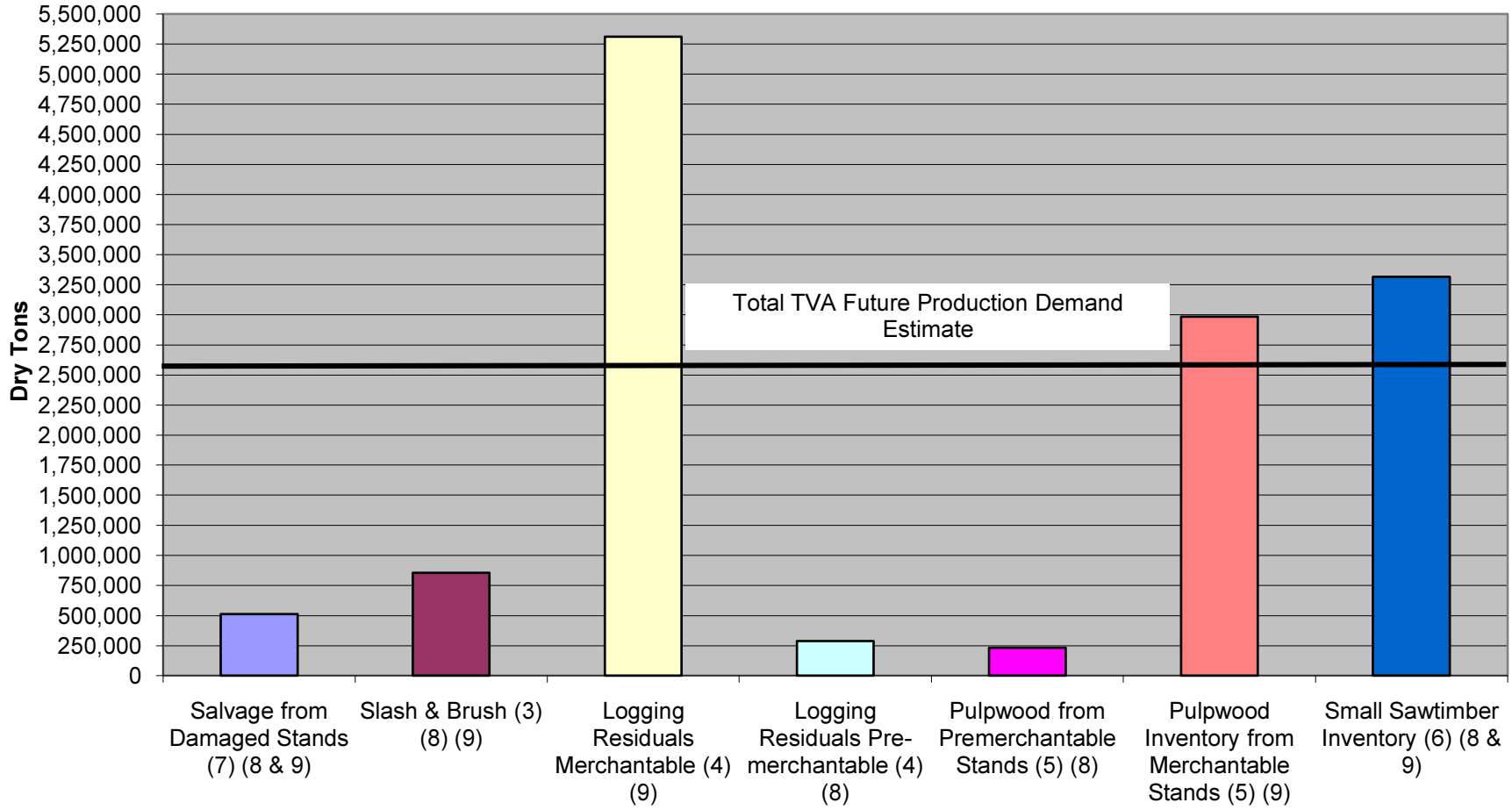
TVA Integrated Resource Plan - Stakeholder Review

Estimated Annual Woody Biomass Supply for TVA Service Area
Source - USFS FIADB Woody Biomass Database including utilization restrictions
Based on Subregional Timber Supply Model (SRTS) Projections of Surplus Growth by FIA Unit



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Biomass Estimate of Urban Wood Waste in TVA Supply Area

Assumptions
2007 Census Population
Urban Wood Waste = Large Diameter Wood Generated by Tree Servicing Companies
Availability Factor - 60% - Carter et al. 2007
Yield = .203 Green Tons/Capita/Year Wiltsee 1998
Dry Tons=.5*Green Tons
Large City > 100,000 Population included 8 Cities
Medium City 25,000 <>99,000 population included 62 cities
Small City <25,000 population included over 1,695 cities

Total Annual Biomass Supply - Dry Tons

	Total TVA Supply Area	Shawnee	Allen	John Seveir	Johnsonville	Paradise	Widows Creek	Colbert	Bull Run	Cumberland	Gallatin	Kingston
Large Cities	181,449	-	39,342	-	-	-	19,657	-	11,131	7,576	35,021	-
Medium Cities	155,833	2,174	11,332	6,330	-	6,652	1,963	2,196	-	1,789	13,179	-
Small Cities	309,438	14,880	14,895	16,145	4,915	6,316	21,869	8,949	10,995	4,505	17,907	6,292
Total	646,720	17,054	65,568	22,475	4,915	12,968	43,490	11,145	22,126	13,870	66,107	6,292

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Scenarios for Supply/Demand Analysis

Scenario 1 - TVA Suggested Co-Fire Plant Conversion	
Megawatts (MW)	20
Equivalent dry tons of wood	112,168
Green tons of wood	224,335
Million BTUs/year	1,890,699
Assumptions	
Moisture content (green weight basis)*	50%
Ash content*	2%
Btu/pound wood**	8,600
Facility capacity factor*	0.83
Heat rate (Btu/kWhr)**	13,002

Scenario 2 - TVA Suggested Dedicated Boiler Conversion	
Megawatts (MW)	50
Equivalent dry tons of wood	280,419
Green tons of wood	560,839
Million BTUs/year	4,726,747
Assumptions	
Moisture content (green weight basis)*	50%
Ash content*	2%
Btu/pound wood**	8,600
Facility capacity factor*	0.83
Heat rate (Btu/kWhr)**	13,002

Scenario 3 - TVA Total Annual Production Projections	
Megawatts (MW)	456
Equivalent dry tons of wood	2,557,424
Green tons of wood	5,114,847
Million BTUs/year	43,107,933
Assumptions	
Moisture content (green weight basis)*	50%
Ash content*	2%
Btu/pound wood**	8,600
Facility capacity factor*	0.83
Heat rate (Btu/kWhr)**	13,002

Scenario 4 - TVA Quoted Annual Biomass Supply Estimate	
Megawatts (MW)	6,419
Equivalent dry tons of wood	36,000,225
Green tons of wood	72,000,450
Million BTUs/year	606,819,790
Assumptions	
Moisture content (green weight basis)*	50%
Ash content*	2%
Btu/pound wood**	8,600
Facility capacity factor*	0.83
Heat rate (Btu/kWhr)**	13,002

Current Production Levels - Page 145 TVA-EIS

Colbert Fossil Plant
Co-Fire Wood Waste
29,000 MWh in 2009

PPA
70 MW Wood Waste

Future Production Levels - page 147 TVA-EIS

Co-Fire Conversion
Pulverized Coal Boilers
Suggested Size 20 MW Annually

Dedicated Boiler Conversion
Stoker/Cyclone/Circulating Boilers
Suggested Size 50 MW Annually

TVA Total Future Production Projections- page 147 TVA-EIS

Co-Fire Conversion
Annual Capacity 169 MW

Dedicated Boiler Conversion
Annual Capacity - 170 MW

New Facilities
Stoker/Circulating Boilers
Annual Capacity - 117 MW

TVA Quoted Annual Biomass Supply Estimate - page 130 TVA-EIS

All Biomass Resources***
36,000,000 Tons Annually

Biomass Energy Generation
47 GWh Annually

*****No distinction between biomass type**

*http://forestencyclopedia.net/Encyclopedia/bioenergy/Encyclopedia_Page.2005-07-19.0020/Encyclopedia_Page.2006-04-12.2315
**NIST - US National Institute of Standards and Technology - 8,600 Bone Dry HHV, 13,002 - 26.25 Efficiency

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Allocation of acres within 50 mile radius of power plant - excluding public lands

Power Plant	% *Outside* FIA Unit	% *Outside* FIA Unit AND Forested	% *Inside* FIA Unit AND Forested
Allen	0%	0%	20%
Bull Run	0%	0%	45%
Colbert	0%	0%	49%
Cumberland	0%	0%	52%
Gallatin	0%	0%	43%
John Seveir	0%	0%	52%
Johnsonville	0%	0%	56%
Kingston	0%	0%	48%
Paradise	6%	2%	40%
Shawnee	41%	9%	25%
Widows Creek	0%	0%	48%
Grand Total	4%	1%	44%

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Current Utilization Rates*

Detail Supply Bucket	TVA Area	Shawnee	Allen	John Seveir	Johnsonville	Paradise	Widows Creek	Colbert	Bull Run	Cumberland	Gallatin	Kingston
Salvage from Damaged Stands (Fire, Insect, Disease) (7)	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Slash & Brush From Non-Damaged Stands (3)	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
Logging Residues (4)	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Pulpwood - Premerchantable (6) (8)	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
Pulpwood - Merchantable (6) (9)	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
Small Sawtimber (6) (9)	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%

*Source
Abt and Seawell - SAFER September 2010, Mulkey 2008

Based on the following customized query of FIA Database March 2010

(1) USFS FIA dry weight of individual tree components (stemwood, top, branches, bark, stump and coarse roots) using component ratio method (CRM) as described in Appendix J Biomass Estimation in the FIADB - FIA Database description and Users Manual for Phase 2, Version 4.0, revision 2, December 2009, Utilizes a compiled set of specie and bark specific gravities to adjust green weight volumes. For smaller trees (saplings and woodland species), only a total biomass value representing wood and bark from ground to tip excluding foliage is available.
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Weighted Average Annual Removal and Growth and Percentage of Inventory

2010 SRTS Model Projections*

With Overlapping Procurement Radius

% of Inventory	Total TVA Supply Area	Shawnee	Allen	John Seveir	Johnsonville	Paradise	Widows Creek	Colbert	Bull Run	Cumberland	Gallatin	Kingston
Pulpwood Removals	2.66%	2.31%	2.73%	2.00%	2.90%	1.51%	3.37%	3.00%	2.91%	2.36%	1.75%	4.19%
Pulpwood Growth	5.19%	6.18%	5.03%	3.96%	2.77%	5.88%	4.76%	3.71%	4.05%	7.42%	10.31%	5.03%
Sawtimber Removals	2.66%	2.32%	2.94%	2.22%	3.19%	1.61%	2.86%	3.47%	2.67%	2.49%	1.73%	3.47%
Sawtimber Growth	5.06%	8.70%	7.35%	5.51%	5.27%	2.97%	4.14%	5.78%	3.29%	6.46%	5.52%	3.53%

Without Overlapping Procurement Radius

% of Inventory	Total TVA Supply Area	Shawnee	Allen	John Seveir	Johnsonville	Paradise	Widows Creek	Colbert	Bull Run	Cumberland	Gallatin	Kingston
Pulpwood Removals	2.66%	2.26%	2.73%	1.99%	2.73%	1.53%	3.36%	3.03%	2.98%	2.48%	1.86%	3.55%
Pulpwood Growth	5.19%	5.68%	4.89%	3.80%	4.29%	6.02%	4.81%	3.85%	3.93%	5.75%	9.67%	4.39%
Sawtimber Removals	2.66%	2.28%	2.92%	2.23%	2.97%	1.62%	2.81%	3.46%	2.76%	2.66%	1.82%	3.10%
Sawtimber Growth	5.06%	8.19%	7.23%	5.49%	5.82%	3.36%	4.19%	5.86%	3.53%	5.90%	5.17%	3.55%

With Overlapping Procurement Radius

Growth-Removals	Total TVA Supply Area	Shawnee	Allen	John Seveir	Johnsonville	Paradise	Widows Creek	Colbert	Bull Run	Cumberland	Gallatin	Kingston
Surplus Growth PW	2.52%	3.88%	2.30%	1.96%	-0.14%	4.37%	1.39%	0.72%	1.14%	5.06%	8.57%	0.84%
Surplus Growth Saw	2.40%	6.38%	4.41%	3.29%	2.07%	1.36%	1.28%	2.31%	0.62%	3.97%	3.79%	0.06%

Without Overlapping Procurement Radius

Growth-Removals	Total TVA Supply Area	Shawnee	Allen	John Seveir	Johnsonville	Paradise	Widows Creek	Colbert	Bull Run	Cumberland	Gallatin	Kingston
Surplus Growth PW	2.52%	3.42%	2.17%	1.81%	1.56%	4.49%	1.45%	0.82%	0.95%	3.27%	7.80%	0.83%
Surplus Growth Saw	2.40%	5.91%	4.31%	3.26%	2.85%	1.74%	1.38%	2.39%	0.77%	3.24%	3.34%	0.45%

*Source - ABT - Subregional Timber Supply Model (SRTS) - 2010 SOFAC V23 Southwide Demand Runs

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Prepared November 1, 2010