Supply Chain Panel

Scale Up 2017

Ottawa

Charles Lalonde, Moderator

Andrew Richard

Chairman and Chief Technical Officer

COMET Biorefining Inc.

London, Ontario

COMET
BIOREFINING

DRIVING THE BIOECONOMY

Comet Biorefining Inc.

Scaling Up 2017

COMET BIOREFINING

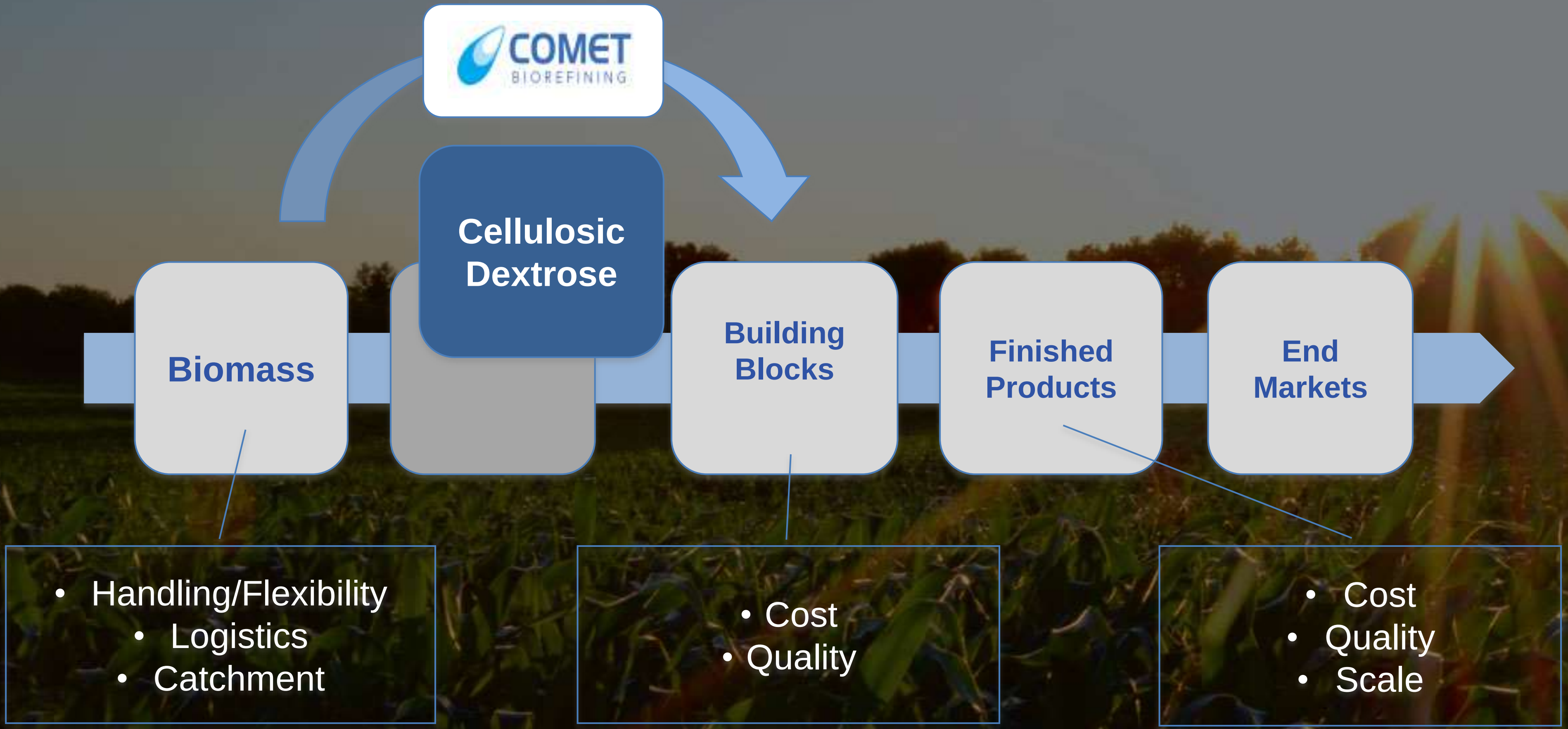
PRODUCER OF COST COMPETITIVE, HIGH PURITY DEXTROSE SUGAR AND CO-PRODUCTS FROM NON-FOOD BIOMASS.

TARGET EXISTING AND DEVELOPING INGREDIENT MARKETS

- FOOD
- BIOMATERIALS
- ANIMAL NUTRITION

COMET BIOREFINING

COMET PLATFORM ADDRESSES VALUE CHAIN CHALLENGES



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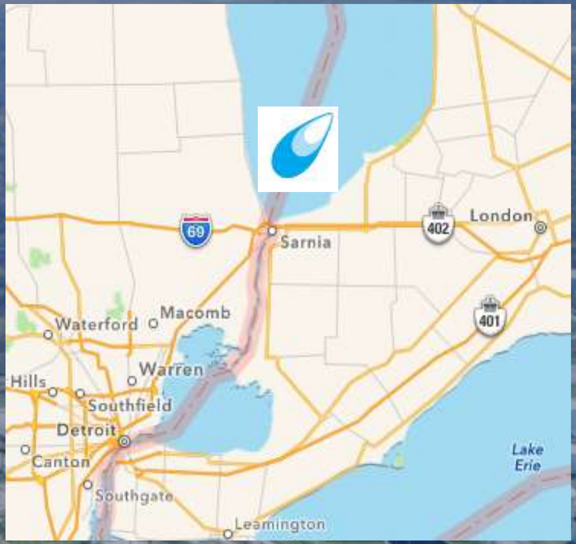

COMET Sarnia – Commercial Site
TransAlta Energy Park - Sarnia, Ontario

- 60 MM lb/year Dextrose (95DE)
- Stover, straw, forest residues
- Food, biomaterials, animal nutrition
- Non-GMO dextrose available

COMET BIOREFINING

COMET/CSPC PARTNERSHIP

CELLULOSIC SUGAR PRODUCERS CO-OPERATIVE®

- Stover/straw
- Project Equity
- Project Debt

COMET SARNIA INC.

FEEDSTOCK COLLECTION AND STORAGE

BIO-REFINERY

- Long term feedstock agrmt
- Aligned investors

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- Technology
- Engineering
- Project Equity
- Project Debt

$ MARKETS

Commercial proof and expansion in SARNIA then roll out to meet global demand

NORTH AMERICA
Wheat Straw Stover
Hardwood Forest Resids

EUROPE
Wheat Straw Stover
Hardwood Forest Resids

SOUTH AMERICA
Bagasse
Eucalyptus Forest Resids

ASIA - OCEANIA
Wheat Straw Palm Resids
Eucalyptus Forest Resids

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Brian Cofell

Cellulosic Sugar Producers Coop
Sarnia, Ontario

CELLULOSIC
SUGAR
PRODUCERS
CO-OPERATIVE®

Brian Cofell
General Manager, CSPC
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A Farmers Perspective....

- Value added opportunity
- Under-utilized crop residue
- Reduced tillage –Lower cost- Less Soil Disturbance
- Earlier Spring planting, resulting in higher soybean yields
- Vertical integration
- Diversifying revenue with sugar
- No extra land required

Cellulosic Sugar Producers Co-Operative

- Membership in Co-Op $500
- Opportunity and obligation to provide biomass of either wheat straw or corn stover $200/acre min. 100 acres
- 1.5 dry MT Corn Stover
- 1.2 dry MT Wheat Straw

Cellulosic Sugar Producers Co-Operative

Clarification of the Offer

- All field work completed by the Co-Op
- No field work completed without the full acknowledgement and consent of the producer
- Producer has the option to vary their ratio of wheat straw and corn stover on an annual basis
- Supply year runs from Sept. 1 – Aug. 30 annually.

Aggregation & Transportation Assumptions

- 3 Harvest Crews
  - 2 windrowers, 2 balers, 1 stacker/crew
  - 5 tractors/crew
  - 2 “spare” balers in fleet,
- 7 specialty built bale trailers
  - 2 full-time tractors & drivers
  - 5 seasonal contractors
- 5 telehandlers
  - For field loading, storage yard and plant service
- 25 acre storage yard
  - Lanes, storage prep, truck scale & scale house
  - Tarps for stored material

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SUGAR
PRODUCERS
CO-OPERATIVE®


nston Rd

Glenn Farris

Fleet Optimization Solutions

AGCO

Deluth, Georgia

Scaling Up 2017

Making the Global Bioeconomy Mainstream

November 27-29, 2017

Fairmont Chateau Laurier

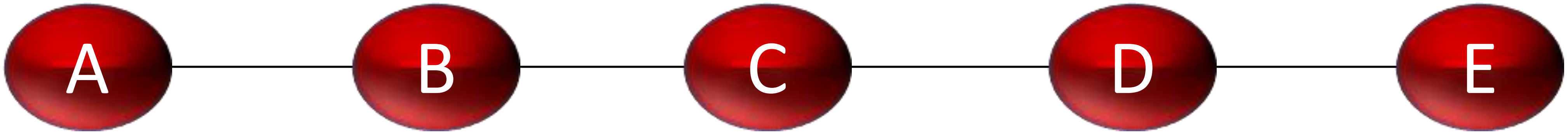
Ottawa, Canada

Responsive

1. Generate Master Plan
2. Establish standards
3. Create Operations Criteria
4. Communicate Plan

Defined

1. KPI’s Identified
2. Develop Methodology for Measurement
3. Supporting Framework Developed
4. Generate Training Materials



Proactive

1. Root Causal Issues Analyzed/Communicated
2. Develop Performance Incentives
3. Improvement Feedback Loops
4. Integrated Information Systems

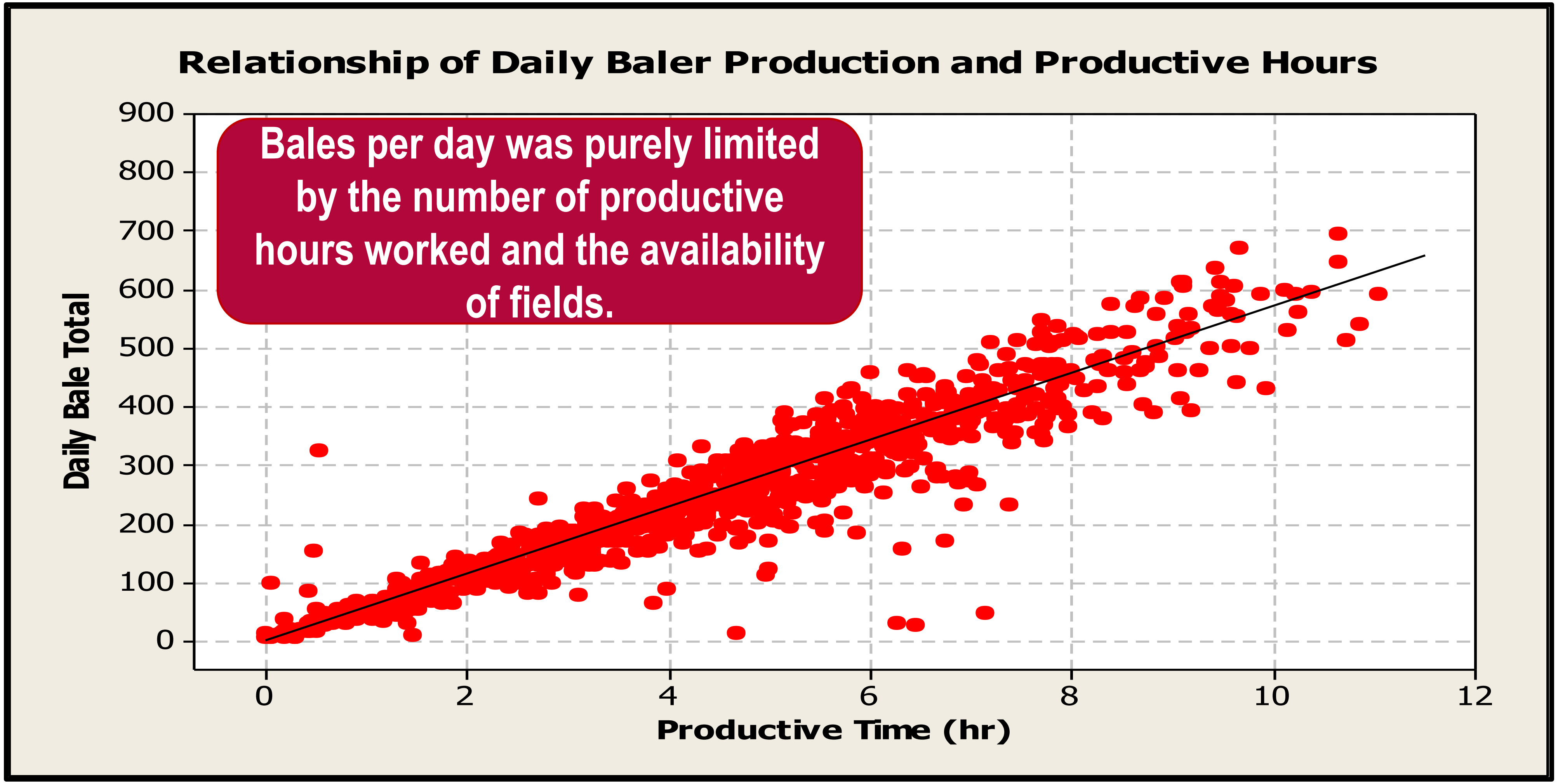
Predictive

1. Complete Cultural Alignment
2. People, Process and Technology Harmony
3. Top Down In Tune with Bottom Up
4. Incentivized Operation

What is Required in a Commercial Logistics Management Solution?

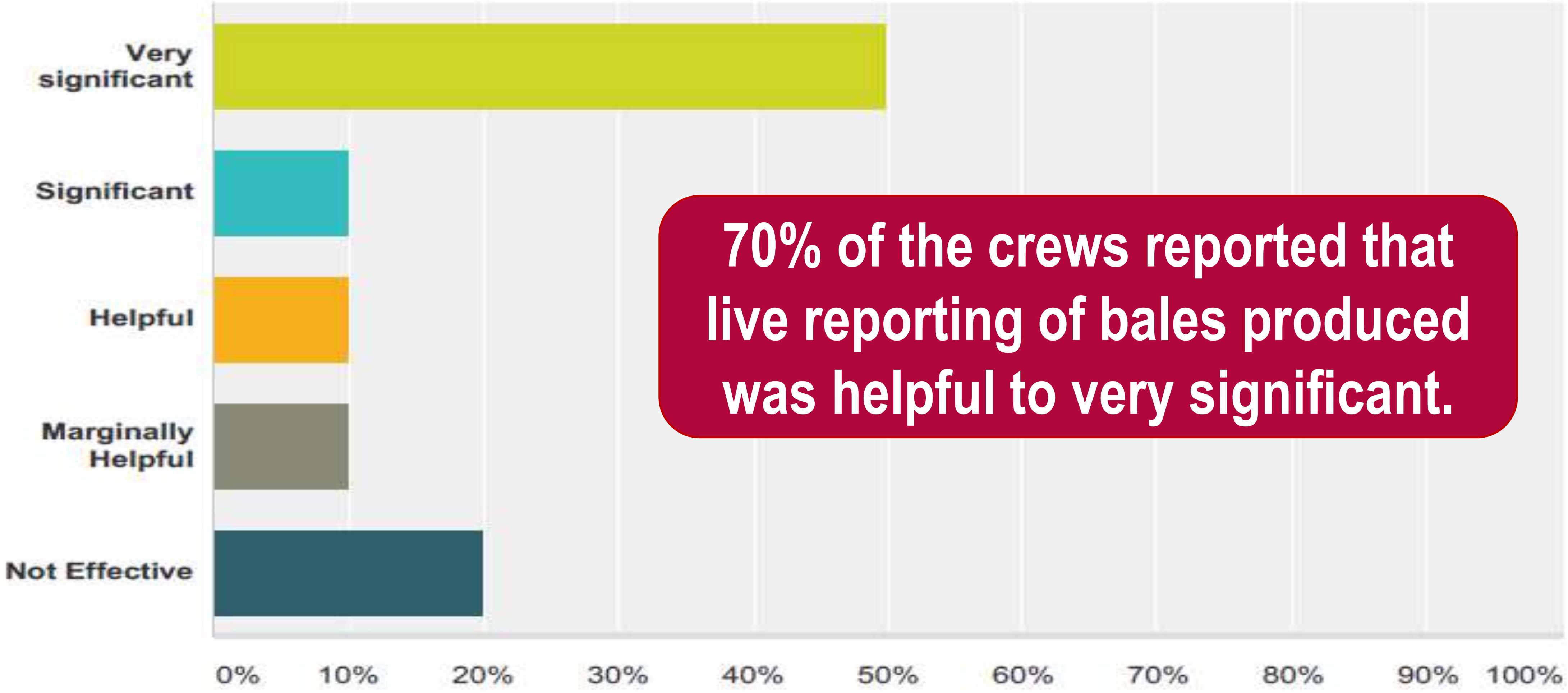
- Direct and actionable <u>knowledge</u> on daily fleet performance and targeted service opportunities.
  - Visual indicators for rapid analysis.
  - Daily, weekly, and seasonal reports for decisions management.
  - Instantaneous reporting for service providers.
- Complete transparency of year-to-date <u>costs</u> and <u>supply chain performance</u> empowered by direct integration of supply chain business rules.
  - Absolutely must report results in units that match the business cost targets. This is both an customer value opportunity as well as a burden to create the flexibility to meet specific customer needs.
  - Must be **<u>brand independent</u>**. Single technology package should provide knowledge across windrowing, baling, stacking, and trucking.
- Telematics data systems allow industrial feedstock managers to:
  - Compare cost of unique harvest teams and incentive strong performance.
  - Make targeted process improvements and certify performance gains.

Do Your Metrics Produce the Desired Result?



Q42 How significant was live reporting of bales produced per day in increasing your baler productivity?

Answered: 10 Skipped: 0

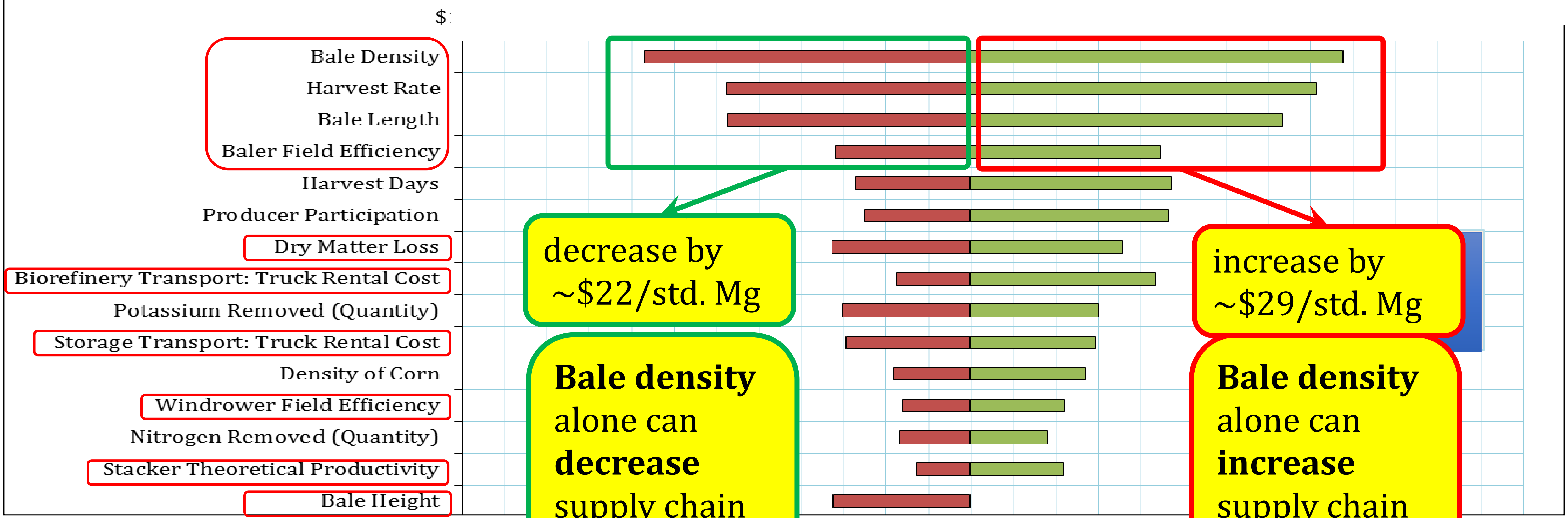


70% of the crews reported that live reporting of bales produced was helpful to very significant.

Sensitivity Analysis: Corn Stover Supply Chain

Top 4 highest supply chain cost influencer related to baling operation

10 out of 15 top supply chain cost influencers related to feedstock supply operations
(i.e., Production-specific parameters)



decrease by ~$22/std. Mg

increase by ~$29/std. Mg

Bale density alone can **decrease** supply chain cost by ~$8/std. Mg

Bale density alone can **increase** supply chain cost by ~$9/std. Mg

Ben Voss

President & CEO Morris Industries

Saskatoon, Saskatchewan


MASSEY FERGUSON

ProAG's Commitment to a Biomass Future

- ProAG has been a key supplier to several agricultural biomass projects
- Our commitment is to provide innovative and high-quality equipment for farmers and contractors
- Reliable and effective logistics for moving bales

Controls & the Collecting of Field Data

Telematics & Future Developments

- IsoBus Integration
- Managing a fleet in-field
- Traceability and bale data collection
- Protecting the biomass feedstock through gentle handling and limiting dirt and ash contamination
- Improved speed, stability and reliability
- Importance of removing bales from fields quickly with minimal compaction

Compatibility with biomass equipment "system"

Reliability Through Customer Service: key to a successful biomass project

- Product Support is critical to a reliable and cost effective operation
  - Training is provided by experts and technical support personnel for the end user
  - Available parts and reliable, fast delivery
  - Dealer network with on-site support
- Listening to customer feedback, continuous improvement

Morris & ProAG

- Large worldwide distribution and dealer network
- Diversified products including seeding, tillage, land preparation and bale handling
- Customer service, support and training
- Parts distribution
- 9 Decades of track record and performance
- Strong research & development
- Modern manufacturing capacity

Jordan Solomon

President & Managing Director

Ecostrat Inc.

Toronto, Ontario

Standardizing an Approach to Biomass Supply Chain Risk:
How New US National Standards Will Drive Industry Growth

Scaling Up Conference – Ottawa November 2017

Jordan Solomon

Managing Director & CEO

Ecostrat Inc.

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Reliable Biomass Supply | Trusted Feedstock Analytics

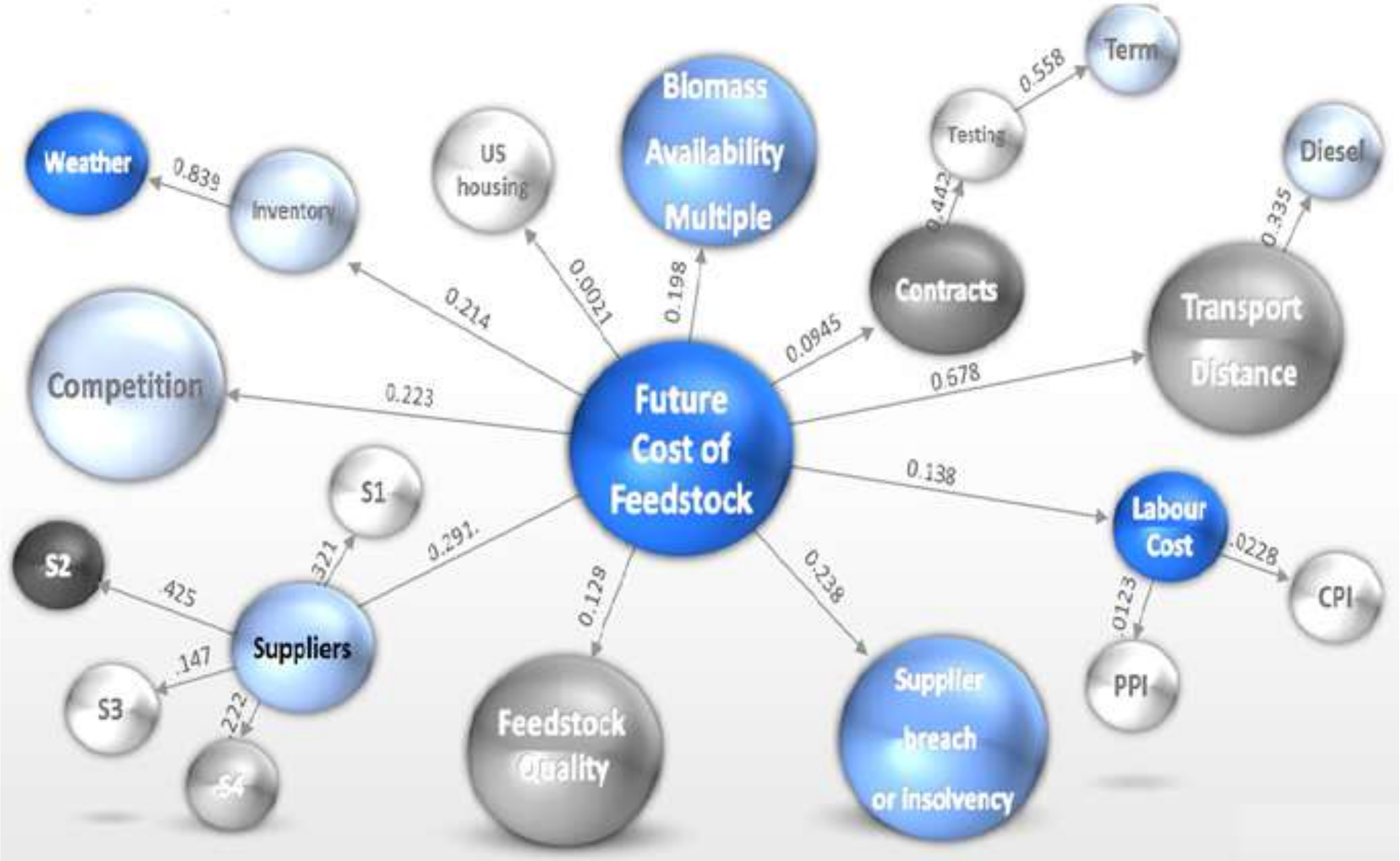
www.ecostrat.com

Why Create Standards for Biomass Supply Chain Risk?

- Currently there are no established protocols, standards, or recognized industry best practices to empirically demonstrate supply chain risk.
- Lack of a standardized and recognized approach means that stakeholders use inconsistent approaches and evaluation criteria, leading to unreliable assessments of project risks.
- This results in significant project financing barriers for bioenergy projects and in millions of dollars of "financial-drag" on the projects that are eventually built
- An established protocol or set of standards will give credit agencies and commercial lenders a common approach and *lingua franca* when attempting to price feedstock risk.

Biomass Supply Chains Are Complex

Multiple components with indeterminate risk of occurrence and impact



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Would you trust this?

$$\Delta G = (V^{L-L}_{\text{bound}} - V^{L-L}_{\text{unbound}}) + (V^{P-P}_{\text{bound}} - V^{P-P}_{\text{unbound}}) + (V^{P-L}_{\text{bound}} - V^{P-L}_{\text{unbound}} + \Delta S_{\text{conf}})$$

$$V = W_{\text{vdw}} \sum_{i,j} \left(\frac{A_{ij}}{r_{ij}^{12}} - \frac{B_{ij}}{r_{ij}^{6}} \right) + W_{\text{hbond}} \sum_{i,j} E(t) \left(\frac{C_{ij}}{r_{ij}^{12}} - \frac{D_{ij}}{r_{ij}^{10}} \right) + W_{\text{elec}} \sum_{i,j} \frac{q_i q_j}{\varepsilon(r_{ij}) r_{ij}} + W_{\text{sol}} \sum_{i,j} (S_i V_j + S_j V_i) e^{(-r_{ij}^2/2\sigma^2)}$$

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How about this?

Results

Description *(US Short Tons)*	Amount	Reference
Growth Drain Ratio (R2)	2.2	R2 = S16 / D6
Available Annual Supply (R3)	**2,600,000**	R3 = S16 - D6
Sustained Annual Harvest Plus Net Growth (S16)	4,800,000	S16 = S7 + S15
% Annual Net Growth after Removals (R1)	**2%**	R1 = S15 - S3
Annual net Growth after Removals (S15)	600,000	S15 = S14 - S3
Sustained Annual Pulpwood Harvest (without net growth) (S7)	4,300,000	S7 = S5 x S6
Competitive Annual Consumed Tons (D6)	**2,200,000**	D6 = D5 x D3
Annual Pulpwood Available for Harvest (S5)	8,700,000	S5 = S3 x S4
Total Ending Pulpwood (after removals plus growth) (S14)	32,100,000	S14 = S11 + S13
Total Beginning Pulpwood (S3)	31,500,000	S3 = (S2c / 100) x 3.37

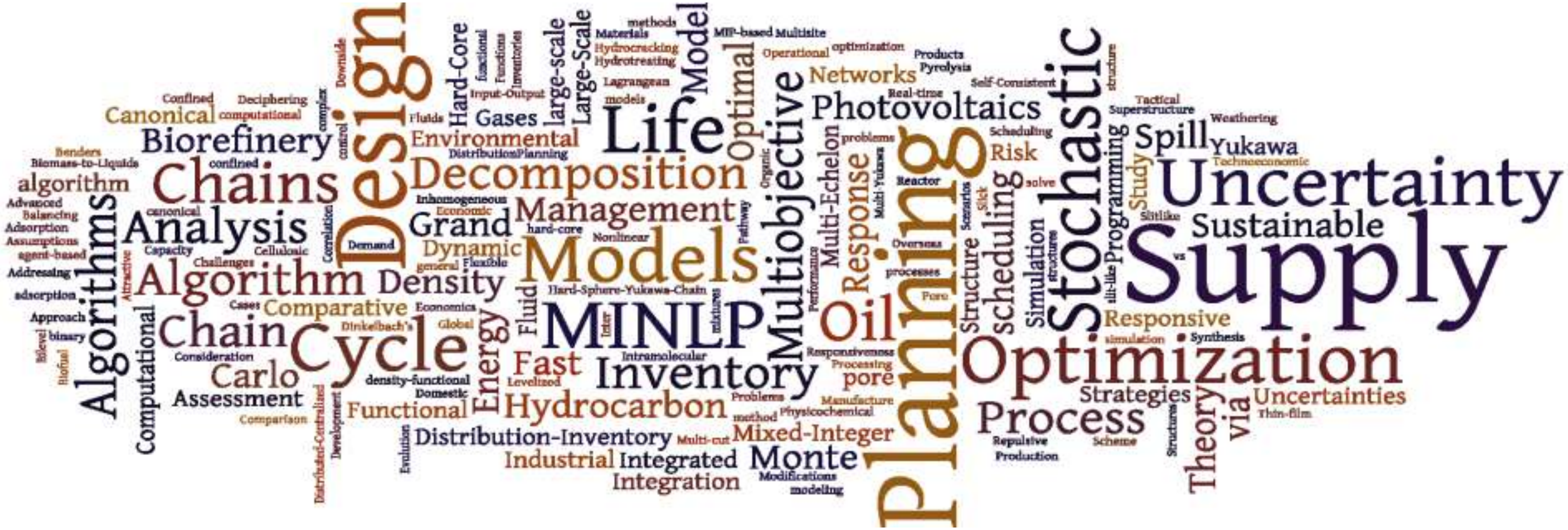
References:
S = Supply
D = Demand (Consumption)
R = Results

Summary

Diameter Classes by Dbh		FIA Pulpwood Data only pulpwood trees ≥5.0" to 10.0" dbh inside each 2" dbh average quadratic mean class			Total Beginning Pulpwood	Annual Pulpwood Available for Harvest		Sustained Annual Pulpwood Harvest (without net growth)		Pulpwood After Annual Harvest	Growth Shifting Dbh Classes		Total after Removal Plus Dbh Shift (before growth)	Growth Inside Dbh Classes		Total Ending Pulpwood *(after removals plus growth)*	Annual Net Growth after Removals	Sustained Annual Harvest Plus Net Growth
S1		S2a	S2b	S2c	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16
US dbh Inches		S2c / S2c sum	FIA	S2b x 1,000,000	(S2c / 100) x 3.37	chart	S3 x S4	chart	S5 x S6	S3 - S7	chart	S8 x S9	(S8 - S10) + S10 preceeding dbh	chart	(S8 - S10) * S12	S11 + S13	S14 - S3	S7 + S15
2" Class	*Range*	*Percent*	*US Cubic Feet (million)*	*US Cubic Feet*	*US Tons*	*Percent*	*US Tons*	*Percent*	*US Tons*	*US Tons*	*Percent*	*US Tons*	*US Tons*	*Percent*	*US Tons*	*US Tons*	*US Tons*	*US Tons*
6	*5.0-6.9*	25%	236.4	236,400,000	7,966,680	4%	339,151	22%	74,285	7,891,685	37%	2,925,569	6,800,039	23.5%	1,168,360	7,968,399	1,719	76,004
8	*7.0-8.9*	48%	451.1	451,100,000	15,202,070	36%	5,510,189	34%	1,897,079	13,305,540	23%	3,002,159	13,228,949	12.8%	1,321,540	14,550,490	(651,580)	1,245,498
10	*9.0-10.9*	25%	230.3	230,300,000	7,761,110	34%	2,674,550	80%	2,134,715	5,646,472	19%	1,091,157	7,557,474	10.5%	477,438	8,034,912	273,802	2,408,518
12	*11.0-12.9*	2%	15.0	15,000,000	505,500	32%	163,782	93%	152,936	351,025	19%	66,628	1,375,554	7.6%	21,727	1,397,282	891,782	1,044,717
≥ 14	*≥ 13.0*	0%	3.3	3,300,000	111,210	31%	34,201	93%	31,940	79,734	0%	-	146,361	5.6%	4,486	150,847	39,637	71,578
		100%	936.1	936,100,000	**31,546,570**		8,721,873		4,290,955	27,274,455		7,085,513	29,108,378		2,993,552	**32,101,930**	555,360	4,846,315

% Annual Net Growth after Removals (R1 = S15 / S3): **2%**
% of total Beginning Pulpwood (S16 / S3): 15.4%
Weighted Mean Average Biological Growth Cross-Check (refer to chart "Growth Percents): 14.9%
% Variance between two methods (variance less than "1%" no adjustments required): 0.44%

For Debt Markets Uncertainty = Risk



So… how do we solve for uncertainty in the supply chain?

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A Standardized Approach to Supply Chain Risk with Credibility

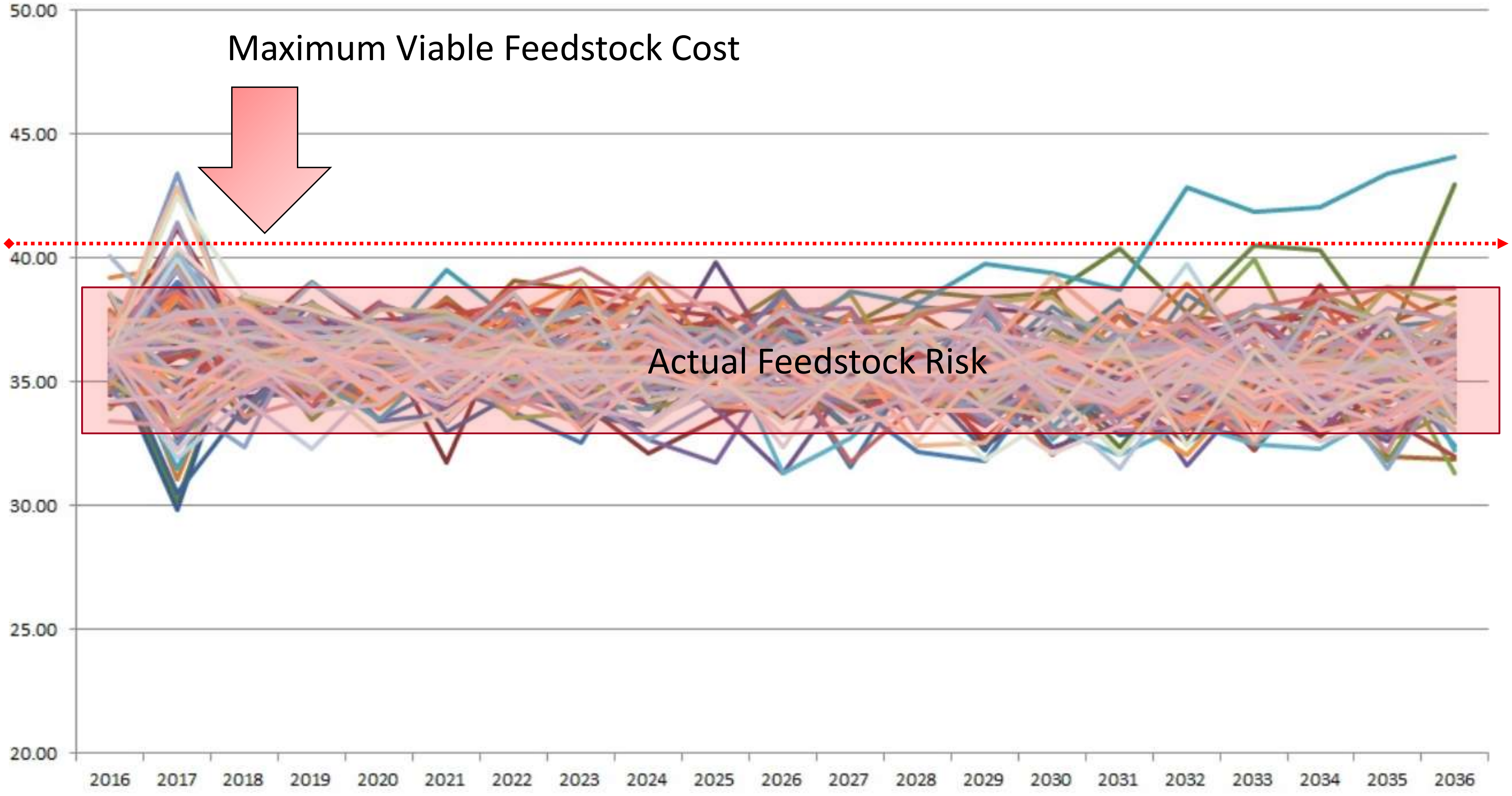
- Development of US National Biomass Supply Chain Risk Standards is a <u>3 year project funded by the US Department Energy</u> though its Bioenergy Technologies Office (BETO).

- Standards are formulated by **Ecostrat** and **INL** (with input from Advisory Board and large Industry Stakeholder Group).

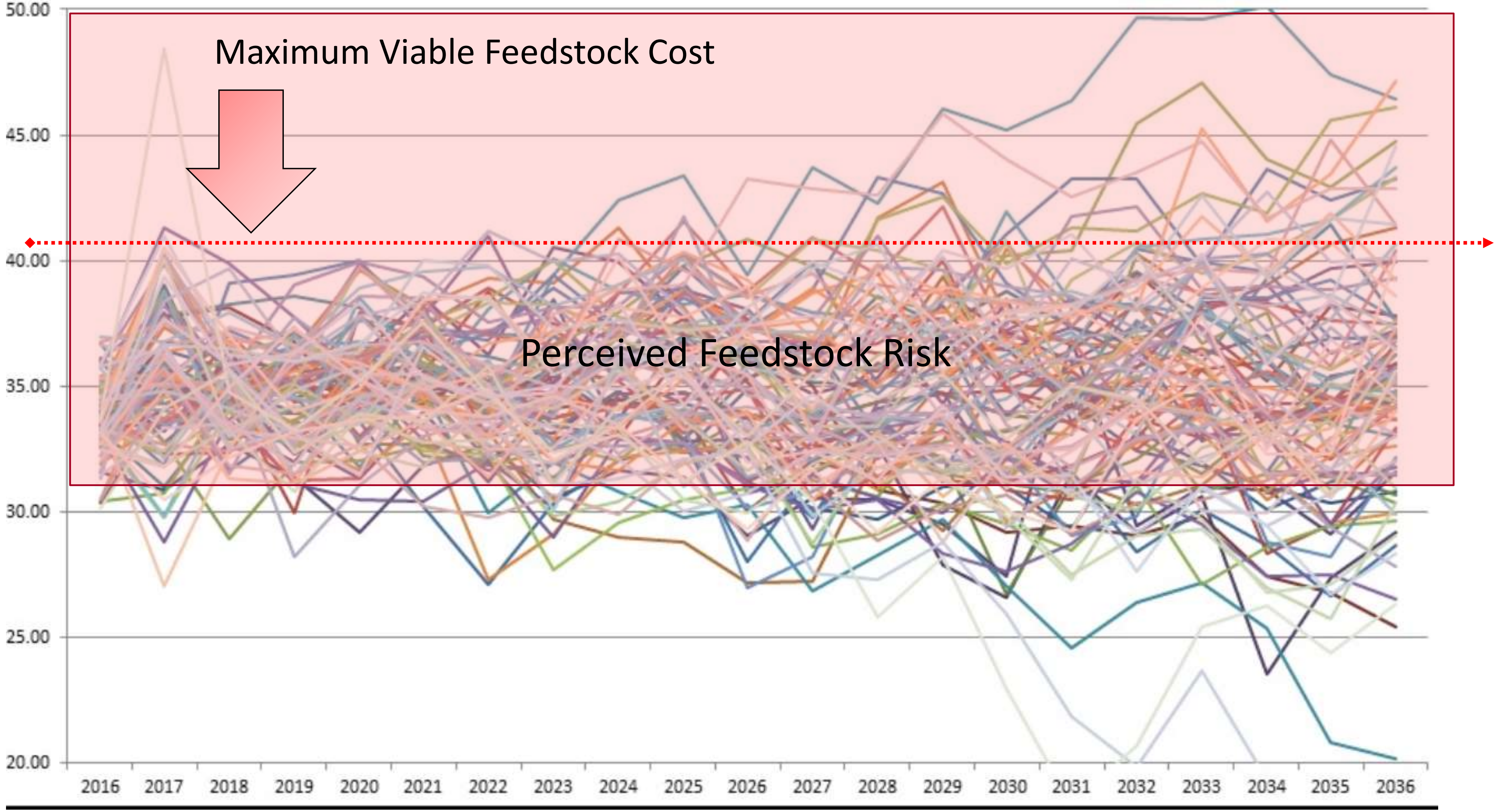
- INL is:
  - the U.S. Department of Energy's national laboratory focused on energy, national security, science and environment with an annual funded budget of $917MM.
  - the nation's leading center for renewable and nuclear energy and biomass feedstock supply chain research.
  - engaged in the mission of ensuring the nation's energy security with safe, competitive and sustainable energy systems and homeland security capabilities.
  - fifth-largest employer in Idaho with 3,900 employees and more than 350 interns.

- Standards are based on the risk-rating methodologies of the major rating agencies-- S&P, Fitch, and Moody's--who were significant contributors to the first draft of the BSCR Standards.

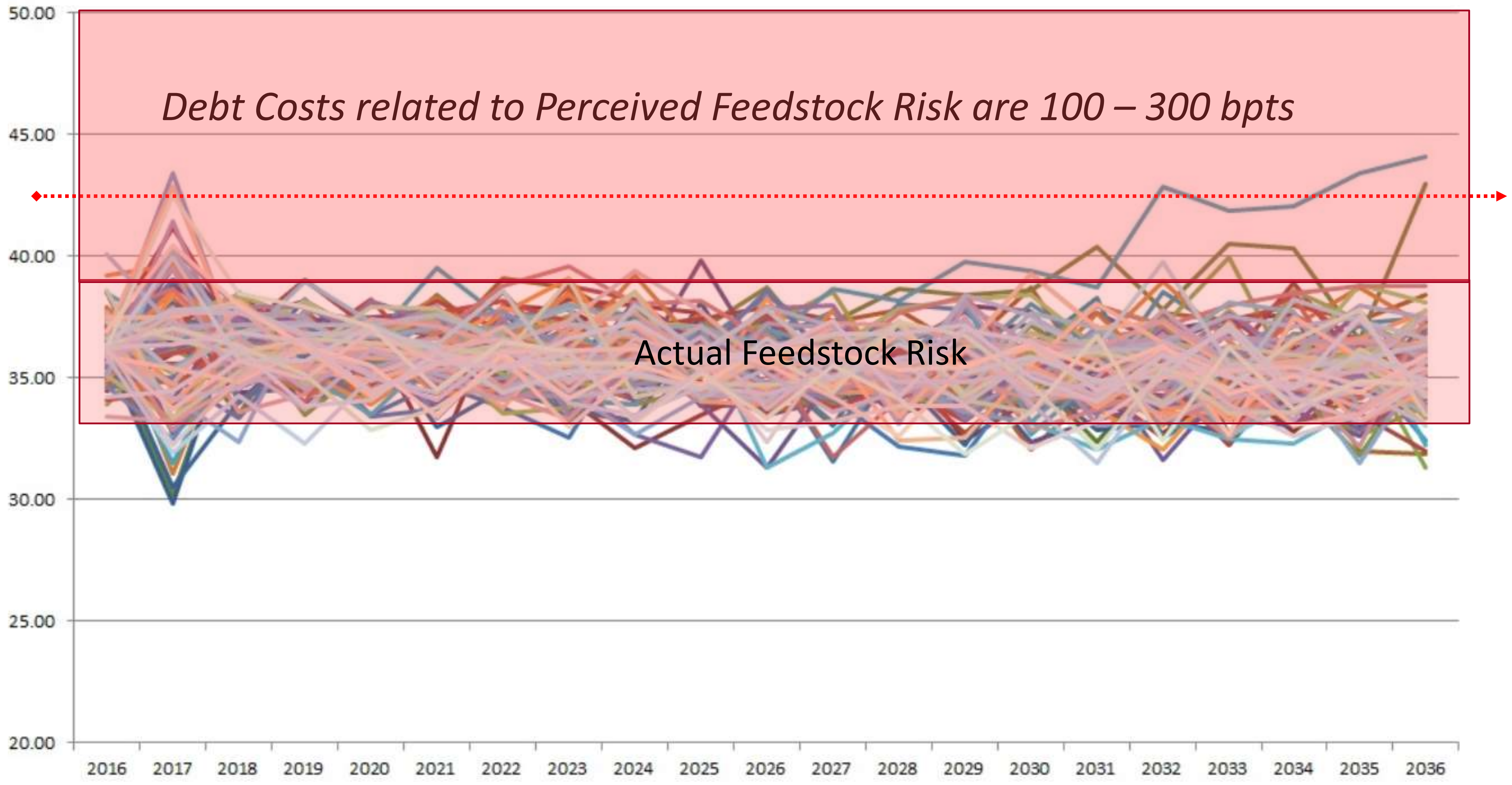
Real vs Perceived Bioenergy Feedstock Risk



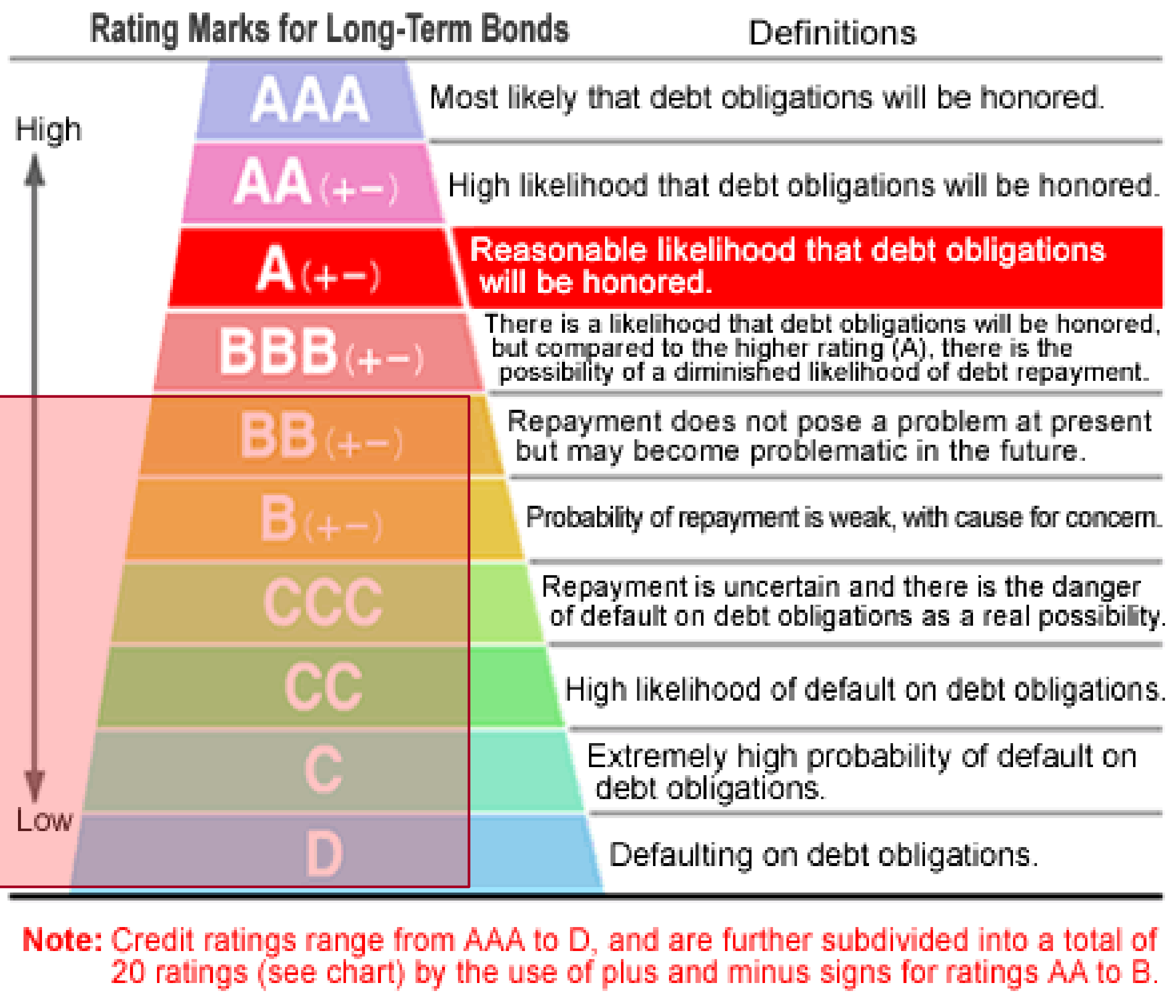
What Happens When Capital Markets are Confused



BSCR Standards Can Help Reduce Debt Cost Due to Perceived Risk



Supply Chain Risk Standards Can Bump Projects by a Ratings Notch (or two)



Typical bioenergy project ratings are in the junk region

Overview of US National Standards for Biomass Supply Chain Risk (BSCR Standards)

- Objective: Develop a framework of standards and certification protocols to allow companies in the biomass sector to clearly demonstrate the risk of their feedstock supply chain to financing sector.

- US National BSCR Standards:
  - a comprehensive compilation of the range of risks that can impact biomass feedstock
  - organized into 6 major risk categories: **Supplier Standards, Competitor Standards, Supply Chain Standards, Feedstock Quality Standards, and Feedstock Scale-Up Standards, and Internal Standards**.
  - will recommend (but not prescribe) methods and tools to quantify, rank and rate supply chain risks on an objective and accepted scale.
  - Will be deployed in FY 2019.

- *Growing industry Stakeholder Group:* Over 30 major banks, project companies, universities have participated in the development of the BSCR standards to date.

What about Canada?

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Real Experience

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Ecostrat Biomass Supply Chain Predictive Analytics

Combined “Model-Layering” approach gives industry-leading predictive accuracy

Chance-Constrained Optimization

Feedstock constraints: 10 year not-to-exceed cost, feedstock quality, shortage.

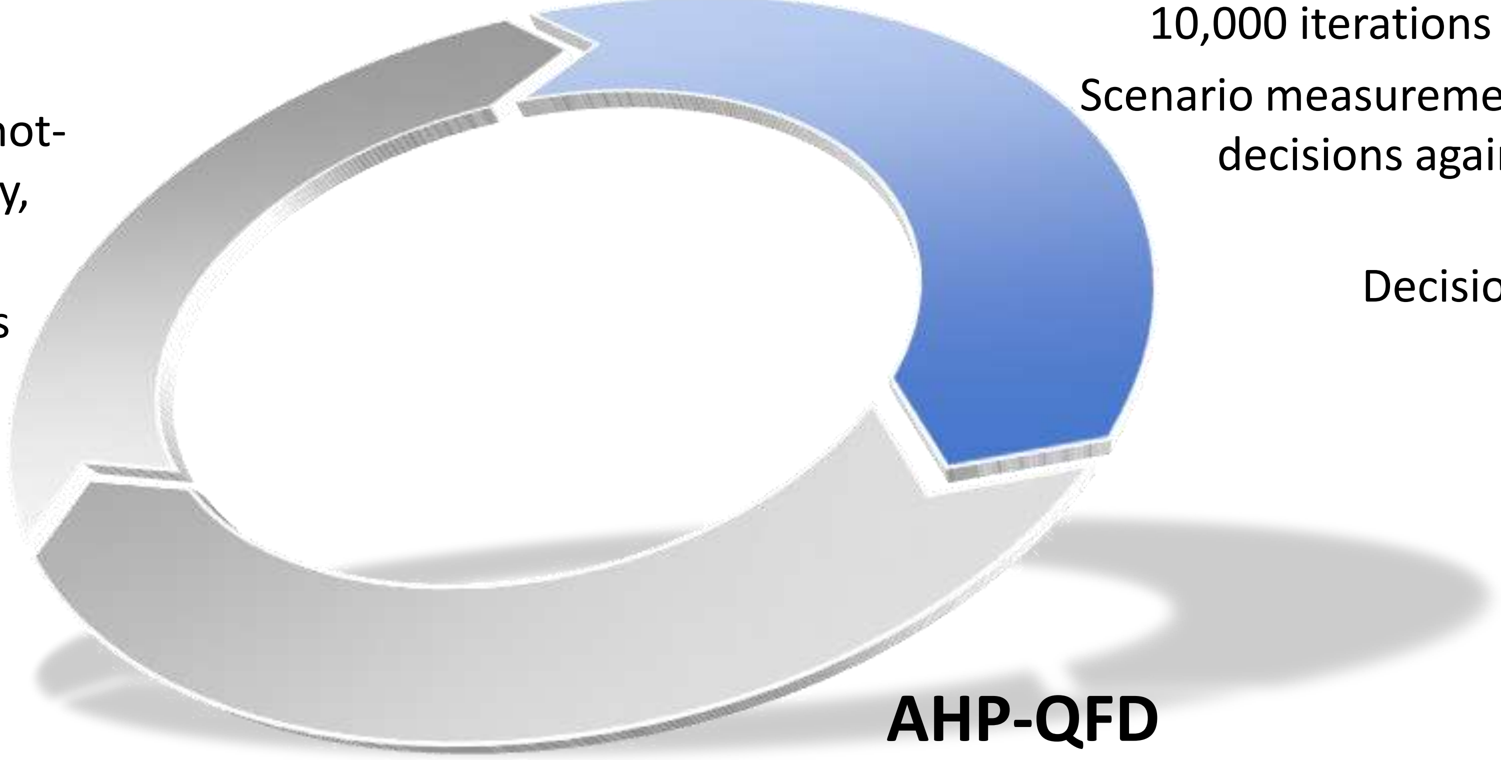
Optimal management decisions regarding feedstock

Monte Carlo Validation

10,000 iterations per variable

Scenario measurement of supply decisions against projects constraints

Decision validation



AHP-QFD

Identificaton of suppliers, feedstock avialability, capacity, quality criteria, price.

Supplier Performence Score

Panel Discussion