Growing a Future of Clean, Renewable Energy

Growing Biofuels Industry Opportunities in Tennessee

TN Renewable Energy & Economic Dev't Council
East Tennessee Forum

February 24, 2012
Madisonville, TN

Kelly Tiller, PhD
President & CEO
Genera Energy LLC

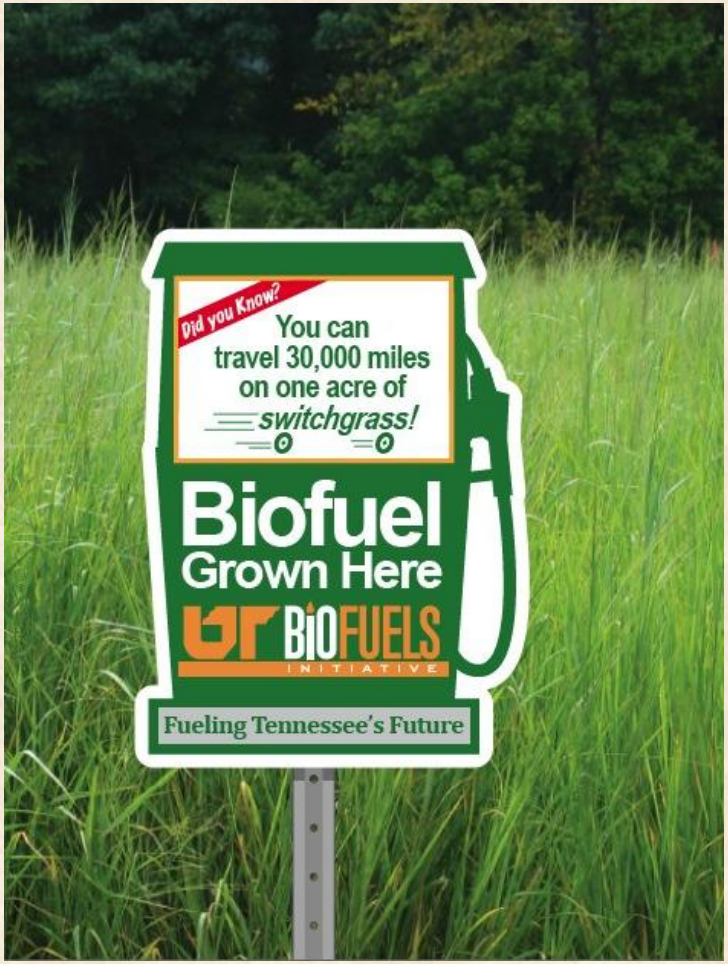
Biofuels … A Long Time Coming

"The fuel of the future is going to come from fruit like that sumac out by the road, or from apples, weeds, sawdust, almost anything. There is fuel in every bit of vegetable matter that can be fermented."

Genera energy

Why Biofuels, Why Now?

- Scalable
- Sustainable
- Familiar, works with existing infrastructure
- Affordable to expand the use
- Reduces emissions
- Cost competitive, thanks to recent technology advances
- Moves in the right direction
- Platform to “replace the whole barrel”, not just gasoline
- Ready to go today



Genera energy

Comprehensive, Integrated Approach

Energy Crop Production

5,100 acres of switchgrass in Tenn.

>60 farms under contract, 9 counties

92% establishment year 1

Mature yields ~8 tons/acre

Feedstock Logistics & Pre-processing

Managing 45,000+ ton inventory

Premier RD&D facilities (BIP)

$5 million DOE logistics project

Commercialization

Demonstrated, scalable model

Developing commercial projects

Strategic partnerships along value chain

Cellulosic Biorefining

250,000 gal demo plant & PDU in Tenn. in collaboration with DDCE

Multiple feedstocks: cob, stover, switchgrass

Operating since January 2010

Genera energy

BIOFUELS INITIATIVE

$70.5 Million Funding from State of Tennessee

Rapid Development in <5 Years

5,100 Acres of Switchgrass

- High yielding, native grass, growing on marginal cropland
- Production contracts with >60 farmers, within 50 miles of Vonore, TN
- In production since 2008, yielding 8 tons/acre today
- Over 90% success in first year stand establishment
- Developed and improving innovations in supply chain logistics

Biomass Innovation Park R&D Campus

- Integrated research campus for biomass handling, processing, storage, densification, transportation
- 22-acre campus adjacent to demonstration scale biorefinery
- Significant flexibility in range of energy crops and processing systems
- Driving efficiencies and innovations between farm gate & biorefinery gate
- Extensive technology partnership & scale-up opportunities

Cellulosic Ethanol Biorefinery

- Demonstration-scale plant, Process Development Unit (PDU), and lab facilities located in Vonore, TN
- Started operations January 2010, processing corn cob, stover, and switchgrass
- Designed to develop technology and engineering packages for the construction of commercial facilities
- Genera collaboration with DuPont Cellulosic Ethanol

The State of Tennessee invested $70.5 million (2007-2012) in an integrated Biofuels Initiative. Genera manages the development & execution of this unique and comprehensive effort.

Genera energy

Introduction to Genera Energy

Cellulosic Ethanol Biorefinery

5,300 Acres of Switchgrass

Biomass Innovation Park R&D Campus

- Since 2008, manage and implement $70.5 million Tennessee Biofuels Initiative
  - ✓ A first-of-kind comprehensive switchgrass-to-ethanol demonstration program
  - ✓ > 5,000 acres of switchgrass in production since 2008
  - ✓ Cellulosic ethanol biorefinery in Vonore, Tennessee
  - ✓ Biomass Innovation Park in Vonore, Tennessee

- Deliver integrated biomass supply chain solutions for a variety of downstream conversion processes
  - Land acquisition, access, easements
  - Energy crop production & stand management
  - Crop harvesting , storage & transport
  - Non-crop biomass accumulation & aggregation
  - Pre-processing of energy crops & other biomass into uniform, industrial biomass feedstocks
- Key research and technology partnerships across the industry value chain to build commercial industry
- Portfolio of crops & biomass sources & services tailored to fit a range of downstream conversion processes
- Private for-profit limited liability company, formed in 2008, wholly owned subsidiary of UT Research Foundation

Genera energy

Switchgrass as an Energy Crop

- Warm season, native, perennial grass
- High yielding, well suited to the SE
  - — Potential for 12+ tons/acre
- Tolerates poor soils, flooding, drought
- Low input use
  - — No irrigation, 60 #/ac N, P & K as needed, no pesticides or fungicides, minimal herbicides
- 1-2 year establishment
  - — Weed control critical in establishment
- Works with existing infrastructure
- Noninvasive, may be removed, improves soil quality
- 25+ year track record as an energy crop

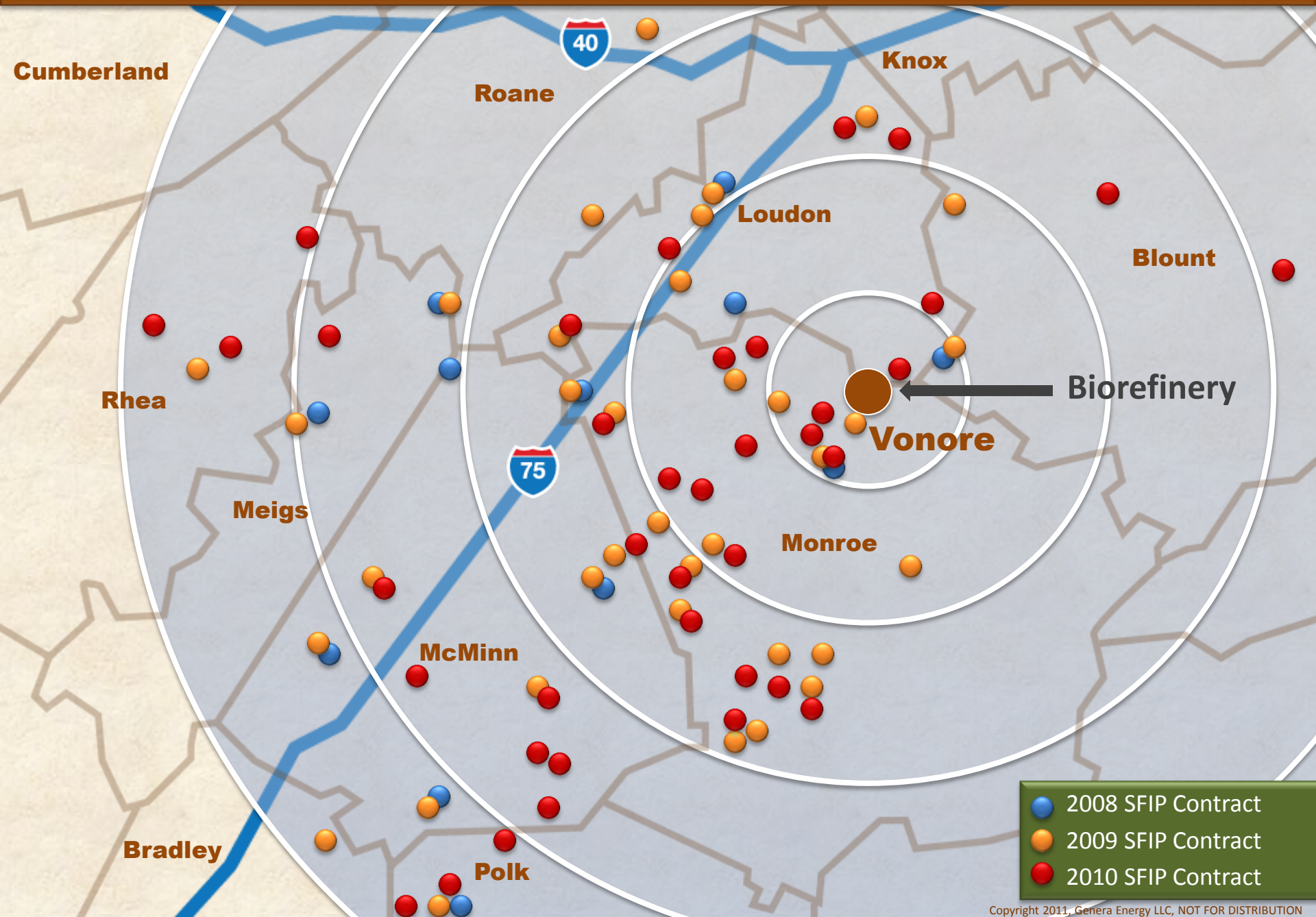
Genera energy

Switchgrass Production

- Contracting with local farmers to produce >5,100 acres of switchgrass
  - In 4th growing season
  - >60 farmers under contract
  - In 9 counties within 50 miles of Vonore
  - Planted 1,000 acres improved varieties
- >90% establishment success in 1st year
- Harvesting about 8 tons/ac by 3rd year
  - ~2 tons in year 1
  - ~5 tons in year 2
  - ~8 tons year 3 and beyond
- Farmers ready and willing to produce switchgrass as a commercial crop

Genera energy

Switchgrass Contract Farms



Switchgrass R&D

- Switchgrass variety improvements and crop genetics
  - – Higher yields, lower lignin, increased seed vigor, herbicide resistance
- Equipment demonstrations
  - – Working with John Deere, Case New Holland, Vermeer, Kuhn, Agco, Stinger
- High-density bale engineering (2-3x)
- Crop agronomics, economics & sustainability
  - – Seeding rates, weed control, nutrient management
  - – Crop insurance, risk management
  - – Carbon sequestration, sustainability indices
- $15 million IBSS grant

Genera energy

Switchgrass Handling Today

- Bale format is conventional method for packaging and handling
  - Large round or
  - Large square
- Shown at right is stacks of round bales behind the Vonore biorefinery
  - Each stack is 3-2-1 pyramids of 5x6 round bales, tarped
  - Each stack is 18-ft high
- Pictured at right is about 5,000 round bales
  - Each bale weighs about 1,000 pounds
  - Would supply feedstock required for a commercial scale (50 MGY) biorefinery for 24-36 hours

Genera energy

Biomass Innovation Park

- World-class RD&D campus, spans gap between the farm gate & biorefinery gate
- Integrates entire biomass supply chain
  - Harvest, handling, storage, densification, logistics, pre-processing, high throughput screening , agronomics, plant genetics, production, Intermediate processing and conversion
- Multiple feedstocks, demo. energy gardens
- Scaled to process 50,000 tons annually
- Site for $5M DOE-funded high tonnage bulk handling demonstration
- Strategic partnership opportunities
- Template for regional biomass depots

Genera energy

Cellulosic Ethanol Biorefinery & PDU

- Partnership with DuPont Danicso Cellulosic Ethanol LLC
- Operating demonstration scale plant and PDU successfully since January 2010
- Started operations on corn cob; operating currently on corn stover
- Have begun to process switchgrass in PDU
- Ethanol produced in Vonore supplying E-85 to UT Motor Pool fleet
- DuPont recently finalized ~$7 billion acquisition of Danisco
- Recent announcement of first DDCE commercial scale project in Iowa

Genera energy

Rapid Biorefining Progress

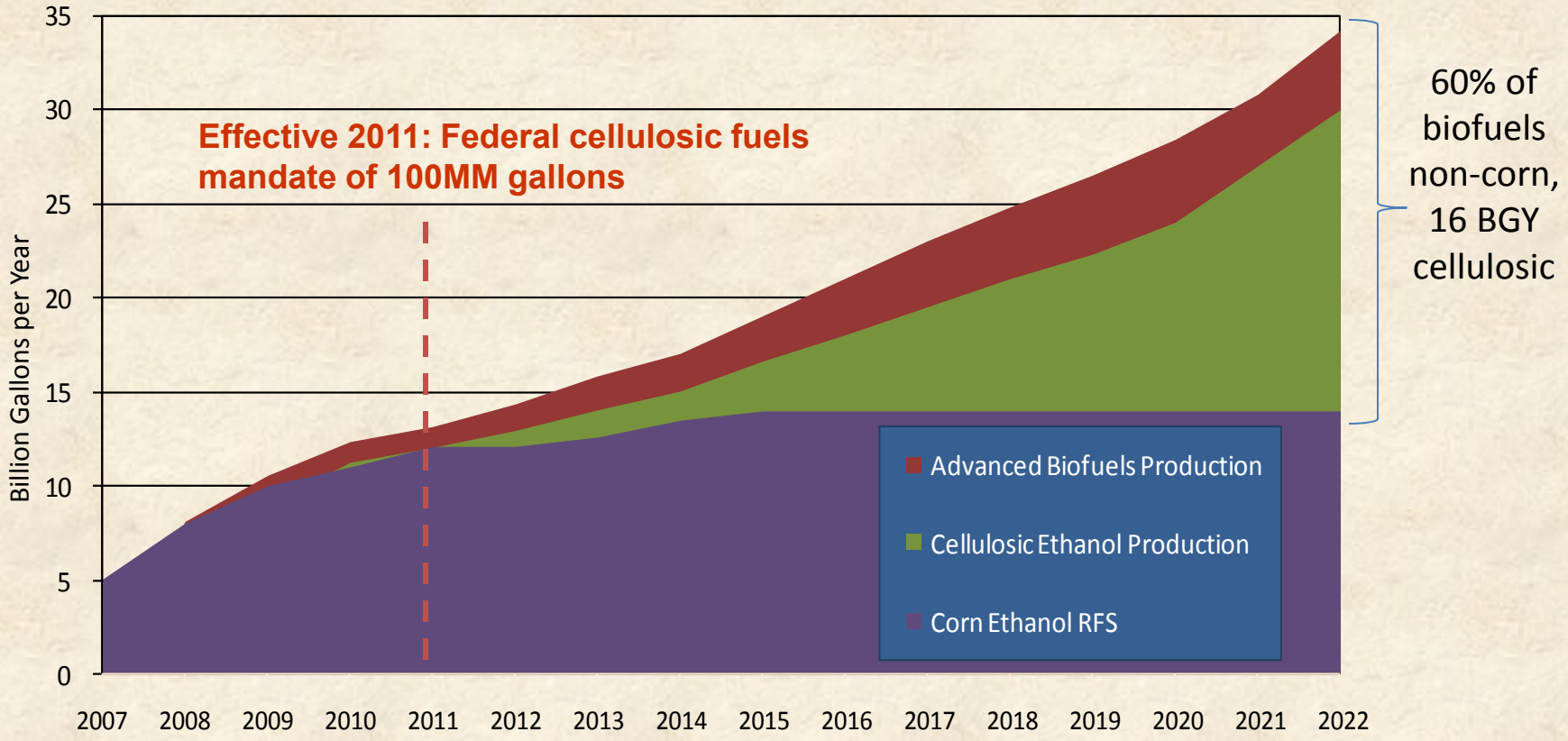
Metric	2007	2011
Technology Maturity	Proven at lab scale	Proven at pre-commercial demonstration scale
Ethanol Yield	60-65 gallons/ton	80-85 gallons/ton
Process Integration	Unproven	Successful integrated operations
Feedstocks	Proven on cob	Proven on cob, stover, switchgrass
Capital Cost	~$8/gallon	~$6/gallon
Enzyme Usage	Baseline dosage	Reduced enzyme dosage 70-80%
Cost of Manufacturing	Projected $3-4/gallon	Projected $1.70/gallon, ~$2/gallon with depreciation

Adapted from data supplied by DuPont Danisco Cellulosic Ethanol, based on integrated processes in production in Vonore, Tenn.

Genera energy

Federal Renewable Fuels Mandate

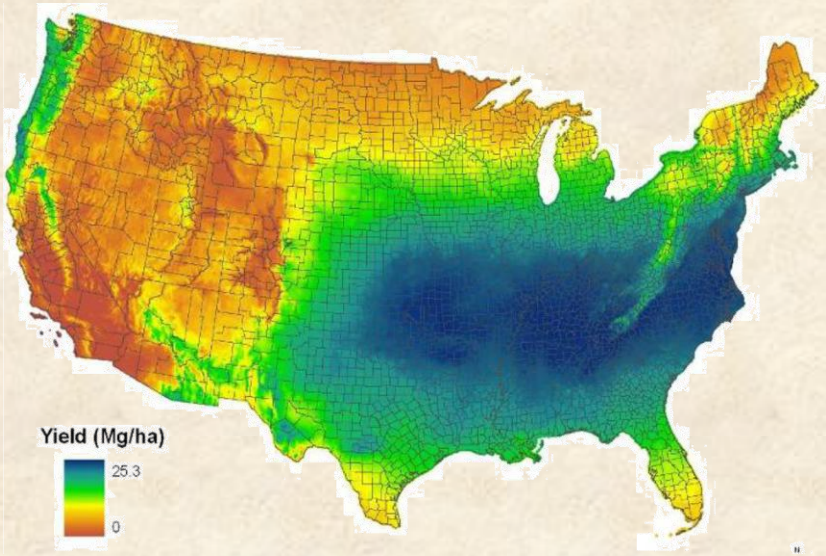
Requires 16 Billion gallons of non-corn advanced biofuels by 2022



Genera energy

RFS2 … A Southeast Target

Biomass



In the **Southeast**, meeting the RFS mandate will require (in 10 years):

- Construction of 263 biorefineries
- $84 billion in capital investment
- 9-10 million acres of land (11% of cropland)

Advanced Biofuel Production from New Capacity (billion gallons)

Region	% of Total Advanced Volume	Advanced biofuels		Total Advanced	Total Advanced
		Ethanol	Biodiesel	Volume	RFS2 Basis (1)
Southeast (2)	49.8	10.45	0.01	10.46	10.47
Central East (3)	43.3	8.83	0.26	9.09	9.22
Northeast (4)	2.0	0.42	0.01	0.42	0.43
Northwest (5)	4.6	0.79	0.18	0.96	1.05
West (6)	<.3	0.06	0.00	0.06	0.06
United States		20.55	0.45	21.00	21.23

Genera energy

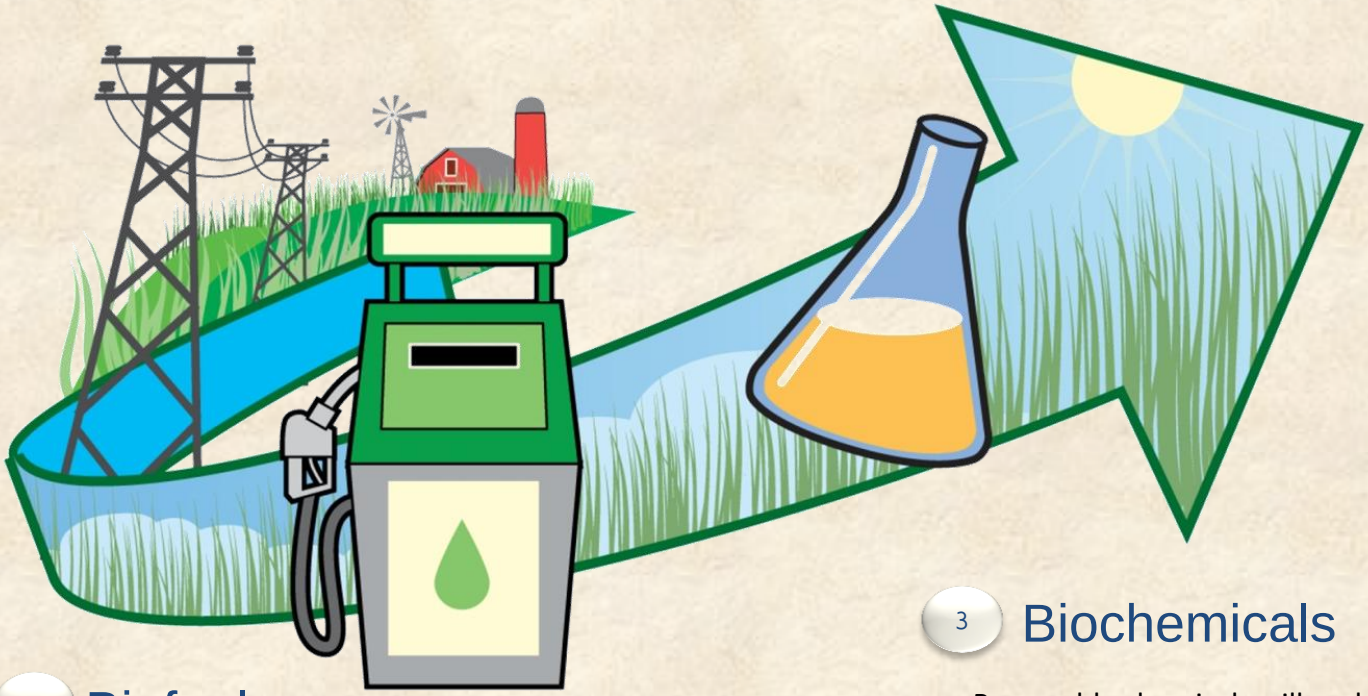
Source: *A USDA Regional Roadmap to Meeting the Biofuels Goals of the Renewable Fuels Standard by 2022.* USDA, June 2010

Addressing Industry Buildout Hurdles

- Feedstock supply risk
  - Feedstock supply guarantee
- Availability of, access to financing
  - Investment grade projects ($300-$400M)
  - Biomass supply ($30-$85M)
  - Opportunity for local investors
- Stable policy environment
- Maintain momentum

Genera energy

Biomass: A Sustainable, Flexible Platform



2 Biopower

- 24 states have renewable power mandates, 5 states have non-binding targets
- 17% of current global market is in the US
- High growth European market for biopower
- Market is cost competitive and policy driven

1 Biofuels

- Federal mandate (RFS2) requires 16 billion gallons cellulosic biofuels by 2022
  - 13.4 Billion GPY expected to come from dedicated energy crops, mostly in Southeast
  - >167 Million TPY of biomass is target market for Genera, >$10 Billion
  - >$80 Billion in biorefinery capital in the SE, some portion funding the project development services Genera provides
- Biofuels projects are commercially viable today, competitive with $90/bbl oil, without any subsidies

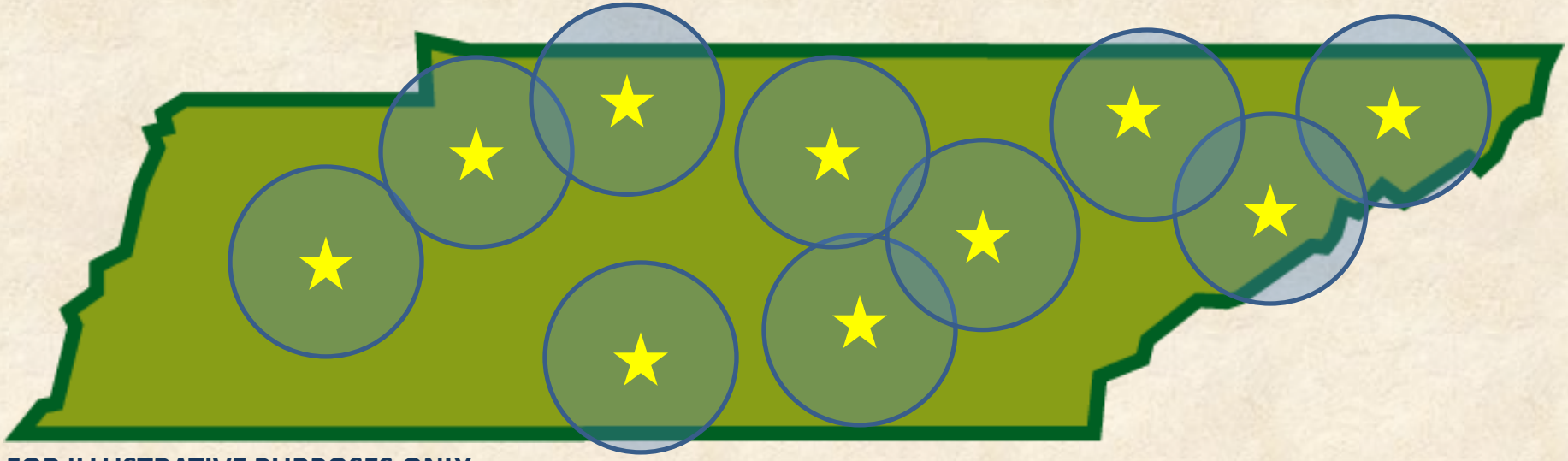
3 Biochemicals

- Renewable chemicals will replace some portion of the $3 Trillion global chemical market
- Higher value products maximize the value of biomass feedstocks and profitability of conversion facilities

Genera energy

Ten-'n-10 – A 2022 Goal for Tennessee

- **Jobs**
  - > 6,000 annual direct jobs
  - Rural job opportunities
  - High-paying manufacturing jobs
- **Economic Development**
  - Statewide
  - Rural and agricultural development
  - Attracts complementary industries
- **Sustainable Land Use**
  - ~800K acres of Tennessee's >1.5M acres of marginal and underutilized ag lands
- **Sustainable Economy**
  - Attracts investment of nearly $6 Billion
  - Generates $775M annual farm revenues
  - Generates $2B in energy sales Tenn. is importing today



FOR ILLUSTRATIVE PURPOSES ONLY

Genera energy

Growing a Future of Clean, Renewable Energy

Kelly Tiller, PhD
President & CEO

Genera Energy LLC
2450 E.J. Chapman Drive
Suite 216
Knoxville, TN 37996

ktiller@generaenergy.net
(865) 974-8258 - office
(865) 809-5805 - mobile