Abengoa Bioenergy : Commercial Scale Biorefinery – Hugoton, KS

IBR Projects Panel – Cellulosic Ethanol
Biomass Technical Advisory Committee Meeting
September 29, 2010

Robert Wooley, PhD, PE
Director, Process Engineering

Science. Solutions. Service.

ABENGOA

Innovative Solutions for Sustainability

With the sun … we produce thermoelectric and photovoltaic electric energy

With biomass … we produce ecological biofuels and animal feed

Waste Management, Recycling, Treatment

With waste … we produce new materials through recycling, and we treat and desalinate water

With information technologies … we manage business and operational processes in a secure and efficient way

With engineering … we build and operate conventional and renewable energy power plants, power transmission systems and industrial infrastructures

With the development of social and cultural policies … we contribute to economic progress, social equity and the nservation of the environment in nities where Abengoa is present

Our Commitment

Abengoa focuses its growth on the creation of new technologies that contribute to sustainable development:

- Generating **energy** from **renewable** resources.
- Recycling **industrial waste**, and generating and managing **water**.
- Developing **information** systems which aid in managing existing infrastructures more **efficiently.**
- Creating environmentally-friendly **infrastructure**.
- Promoting **new avenues** of development and innovation.

And to achieve this:

- We invest in **research, development and innovation** (R+D+i).
- We expand those **technologies** with the greatest potential.
- We develop the necessary **talent** by attracting and retaining the very best people.
- We allocate human and financial resources to promote **socially responsible policies** that contribute to **social and human development**

ABENGOA BIOENERGY

The Global Ethanol Company
Leading First Generation

Cartagena, Sp
40 MMGY
Since 1999

Coruña, Sp
55 MMGY
Since 2001

Salamanca, Sp
55 MMGY
Since 2006

Lacq, FR
70 MMGY
Since 2007

Rotterdam, NE
130 MMGY
Construction

San Roque,Sp
70 MMGY
Since 2009

York, NE
55 MMGY
Since 1994

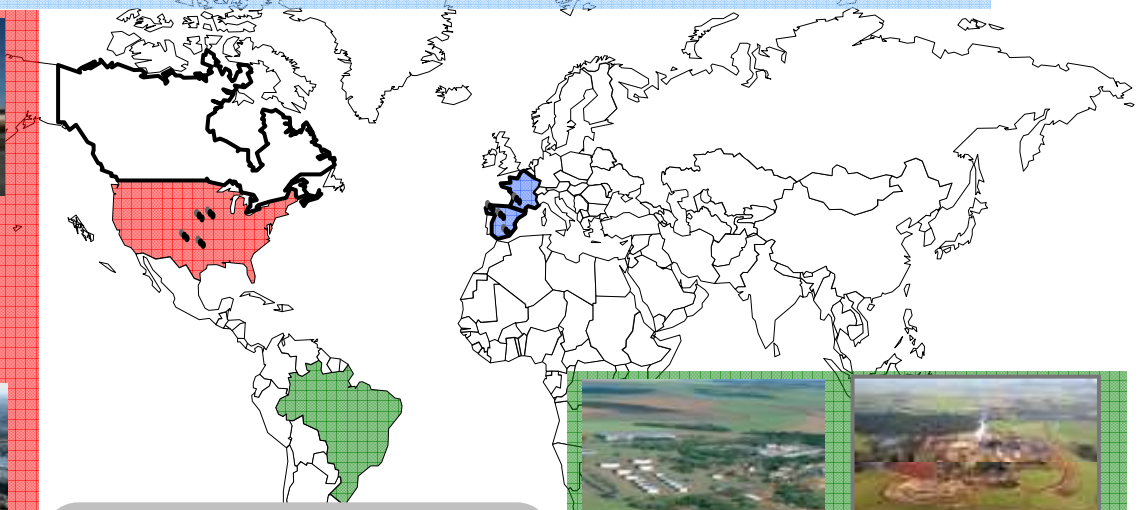
Colwich, KS
25 MMGY
Since 1984

Portales, NM
30 MMGY
Since 1997

Ravenna, NE
92 MMGY
Since 2007

Evansville, IN
90 MMGY
Since 2009

Tricity, IL
90 MMGY
Since 2010



Total - Million Gal/y

	2008	2010
Prod:	575	840

San Luis, SP
3.3 Mt/y
Since 2007

San Joao, SP
2.8 Mt/y
180 ML

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Second Generation Fuels

Corn Ethanol Is Not Finished

Abengoa believes passionately in further development of first generation ethanol

- Only renewable fuel currently available on commercial scale
- Corn ethanol cash flow: needed step to commercial second generation fuels
- Corn ethanol is building the infrastructure needed for other fuels
- Technological & agricultural advances create environmental improvement
- Profitable value chain with seed, fertilizer, Ag and ethanol companies making money

Abengoa Bioenergy Assets

Commercial Hybrid Biomass Plant Hugoton (KS, US)

- Capacity : 16 MGPY Cellulosic Ethanol, 75 MW Renewable Power
- Raw material : Corn Stover, Wheat Straw, Switchgrass
- Technology : Enzymatic Hydrolysis (glucose & xylose)
- Objective : Production at a gasoline competitive cost
- Start-up Operations : 2013

Biomass Demonstration Plant in BCL (Salamanca, Spain)

- Capacity : 1.3 MGPY
- Raw material : Wheat and Barley Straw
- Technology : Enzymatic Hydrolysis (glucose)
- Objective : Demonstrate biomass -to-ethanol process technology at commercial scale
- Start-up Operations : 2009

Biomass Pilot Plant in York (NE, US)

- Capacity : 0.02 MGPY
- Raw material : Corn stover
- Technology : Enzymatic Hydrolysis (glucose & xylose)
- Objective : Competitive process with grain ethanol
- Start-up Oper. : 2007

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Cellulosic Ethanol – A Long and Torturous Path

- High Hopes for Cellulosic Ethanol by 2000
  - DOE – Biofuels Office Goal
  - Hopefuls
    - BC International – Got Very Close
    - Arkenol – JGC Efforts
    - Masada - ?

Cellulosic Ethanol – A Long and Torturous Path

- 2005 US Congress Mandates Cellulosic Commercial Facilities with Section 932 of the Energy Policy Act
- Minimum Requirement: 700 dry metric tons/day
- 2006 Awardees
  - Abengoa Bioenergy
  - Poet
  - Bluefire (Arkenol)
  - Range Fuels
  - Iogen
  - ALICO

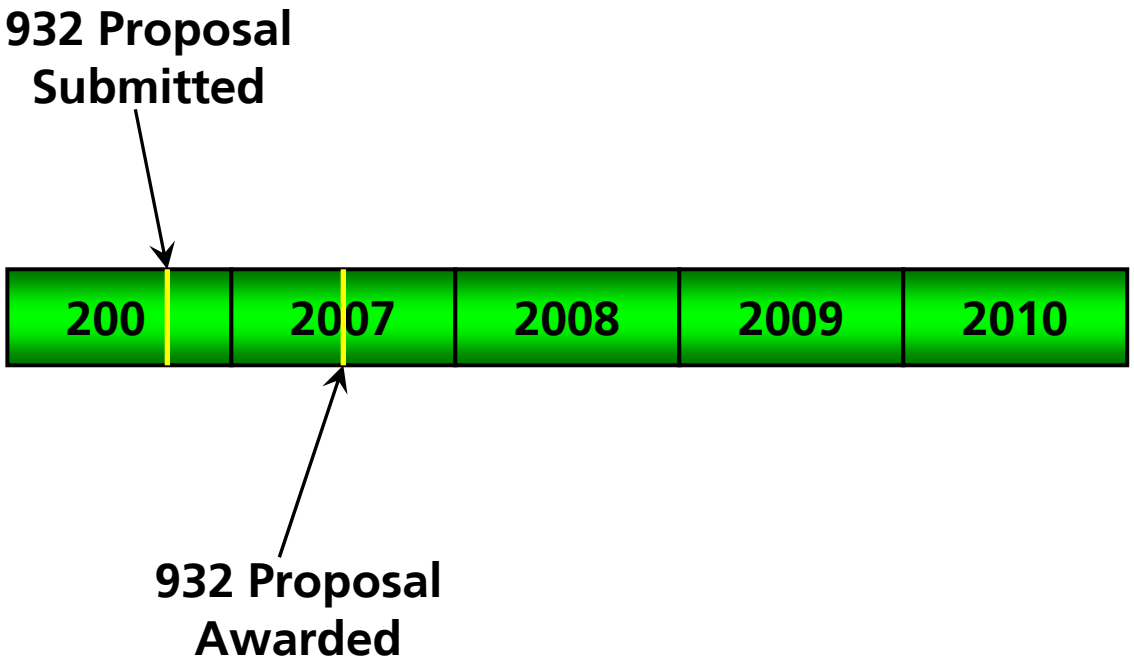
Abengoa Bioenergy Cellulosic Ethanol – Strategic Plan

- First commercial facility of Abengoa Bioenergy's Cellulosic Ethanol Technology

- A key first project in the Nation's Cellulosic Ethanol Industry

Abengoa Bioenergy Cellulosic Ethanol – Time Line or Moving Target

Project Scope
400 t/d Enzymatic Ethanol
300 t/d Gasifier / Boiler



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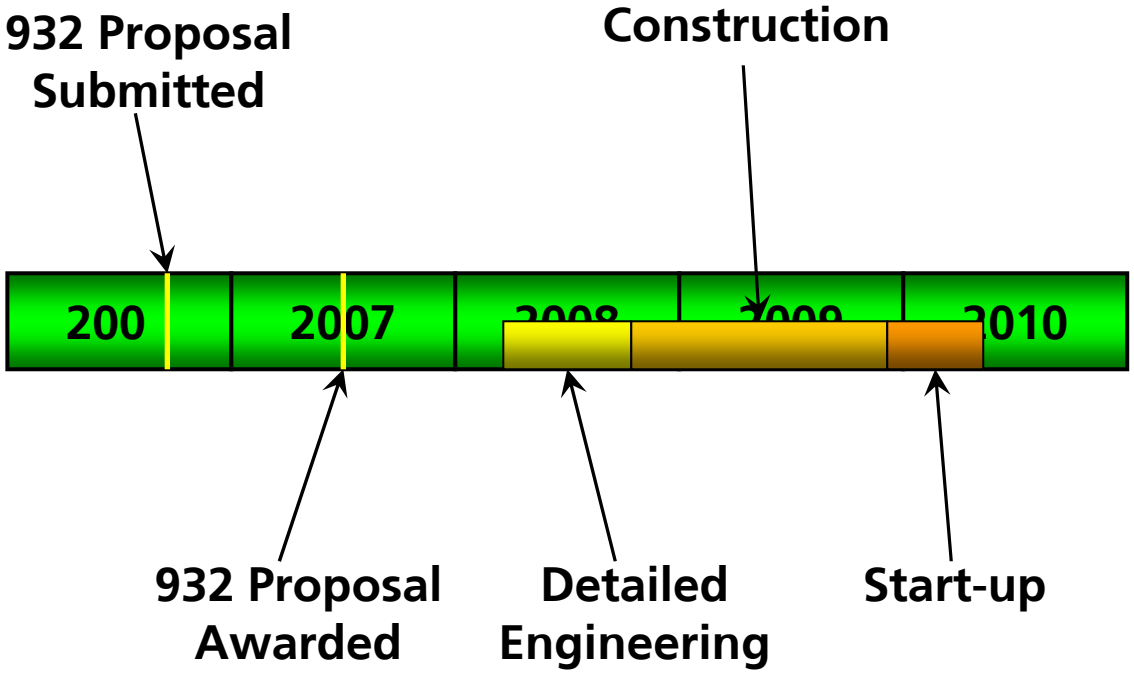

Project Scope
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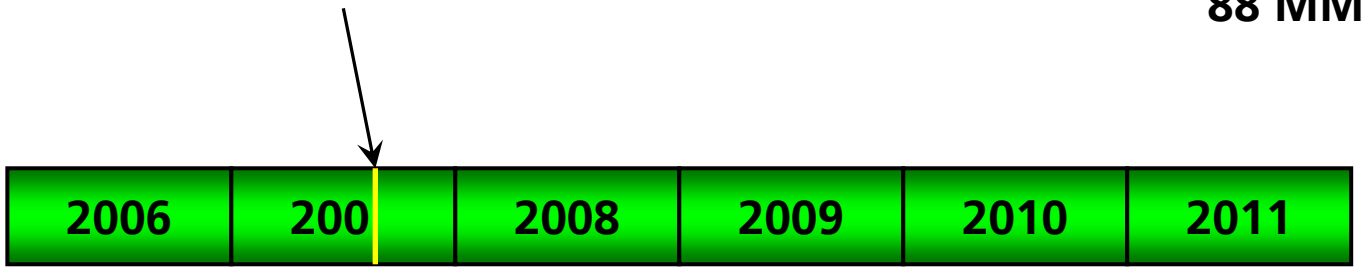
Abengoa Bioenergy Cellulosic Ethanol – Time Line or Moving Target

Modified Scope & Timeline

Project Scope
400 t/d Enzymatic Ethanol
300 t/d Gasifier / Boiler
88 MM gal/yr Corn EtOH



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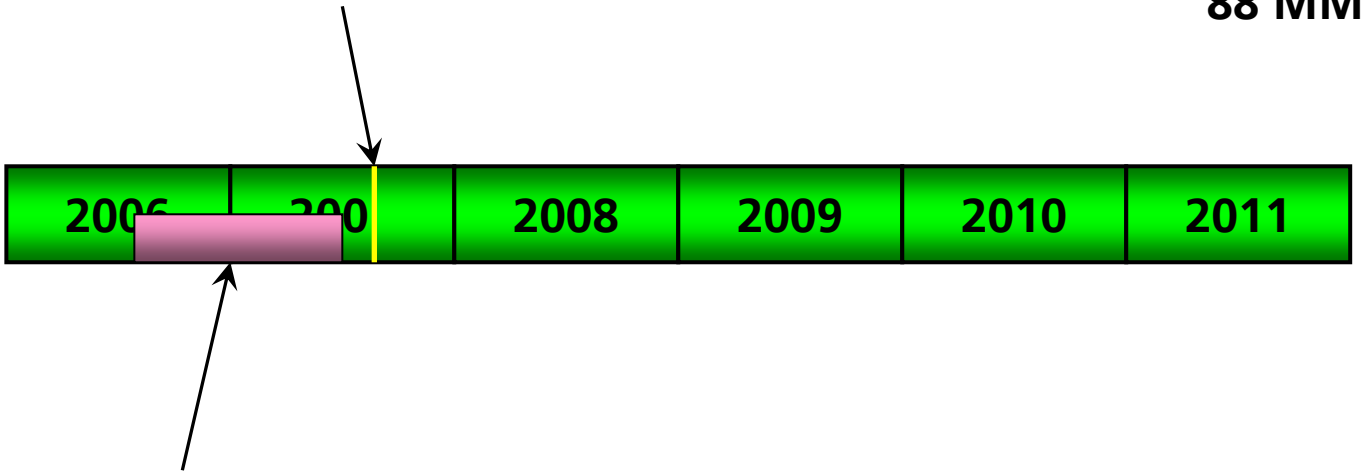

Location Moved
Colwich, KS – Permit Issues
Dodge City, KS – Water Availability
Hugoton, KS

Abengoa Bioenergy Cellulosic Ethanol – Time Line or Moving Target

Modified Scope
& Timeline

Construction

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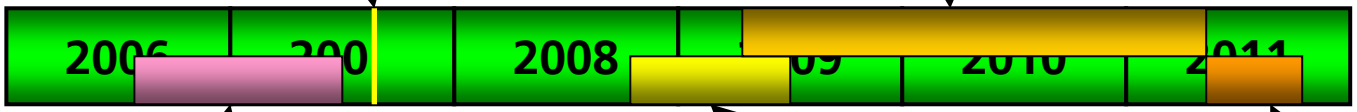
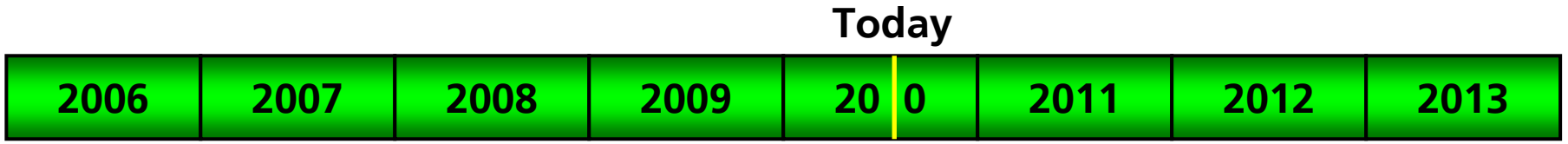


Location Moved
Colwich, KS – Permit Issues
Dodge City, KS – Water Availability
Hugoton, KS

Detailed
Engineering

Start-up

Abengoa Bioenergy Cellulosic Ethanol – Time Line or Moving Target



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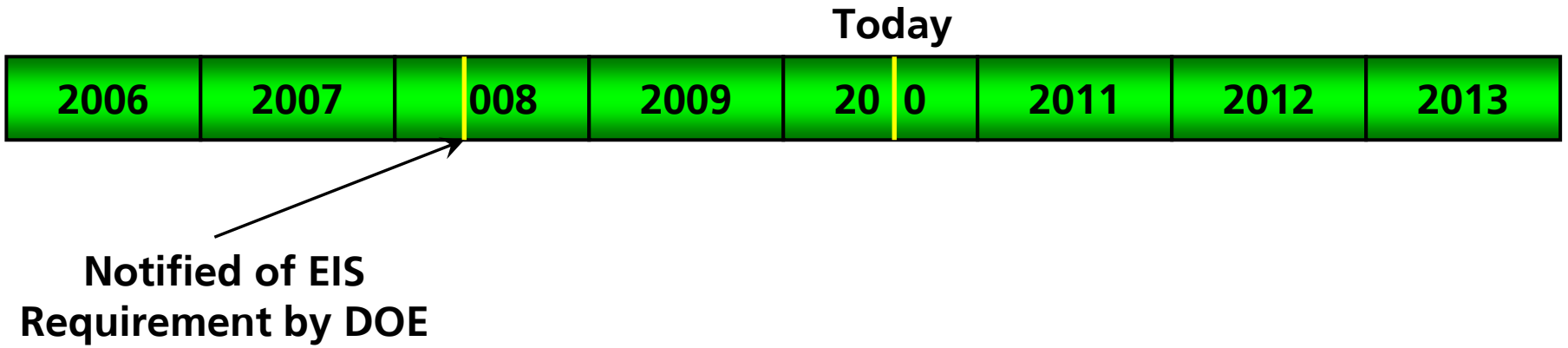

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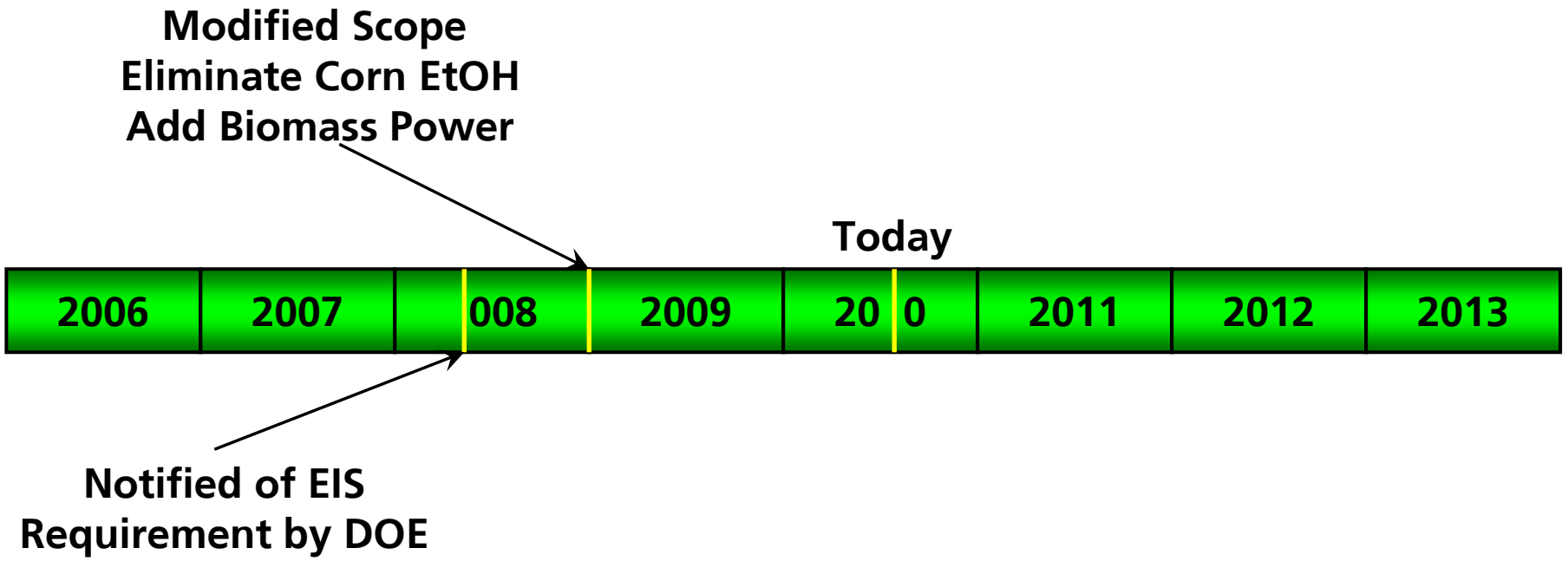

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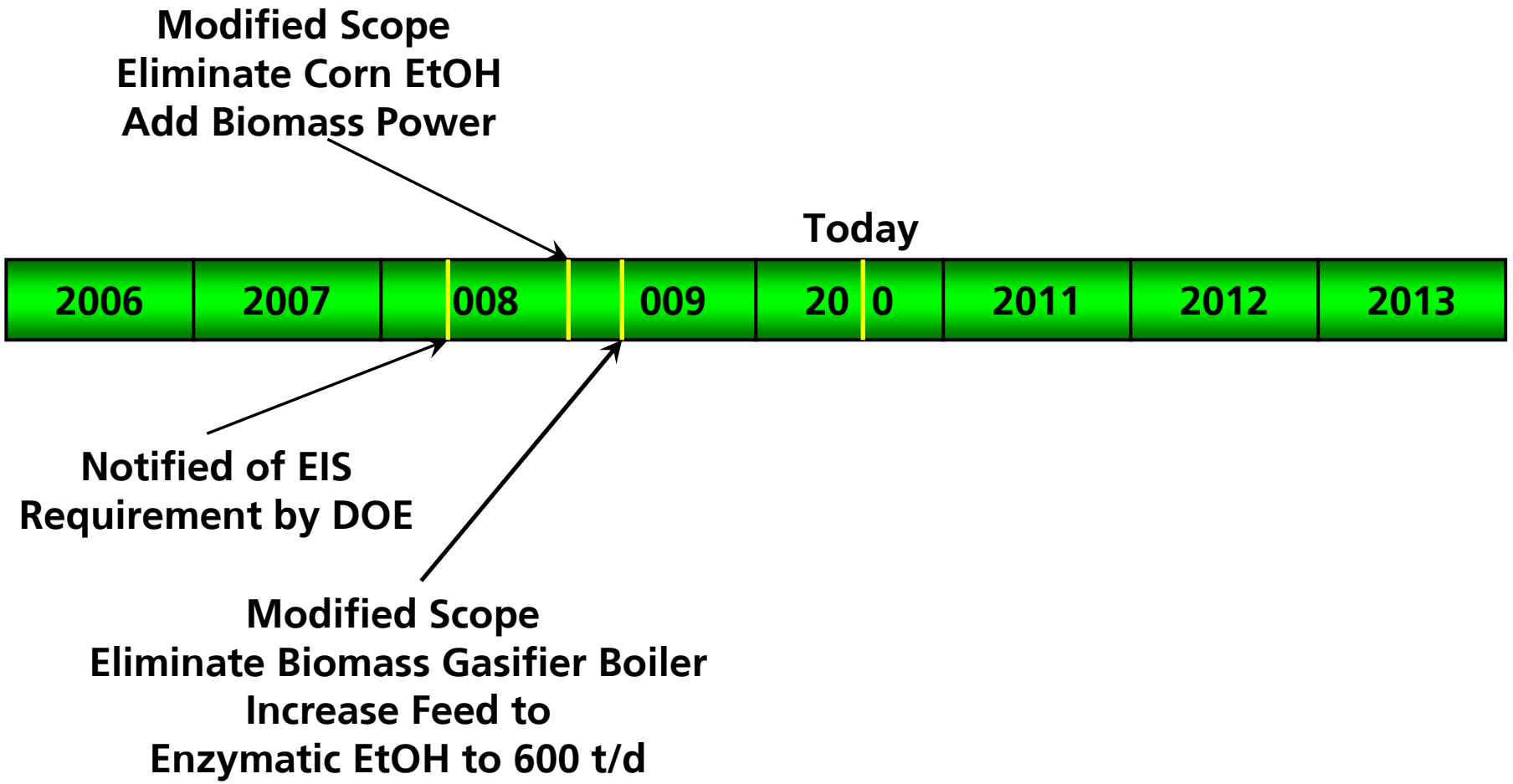

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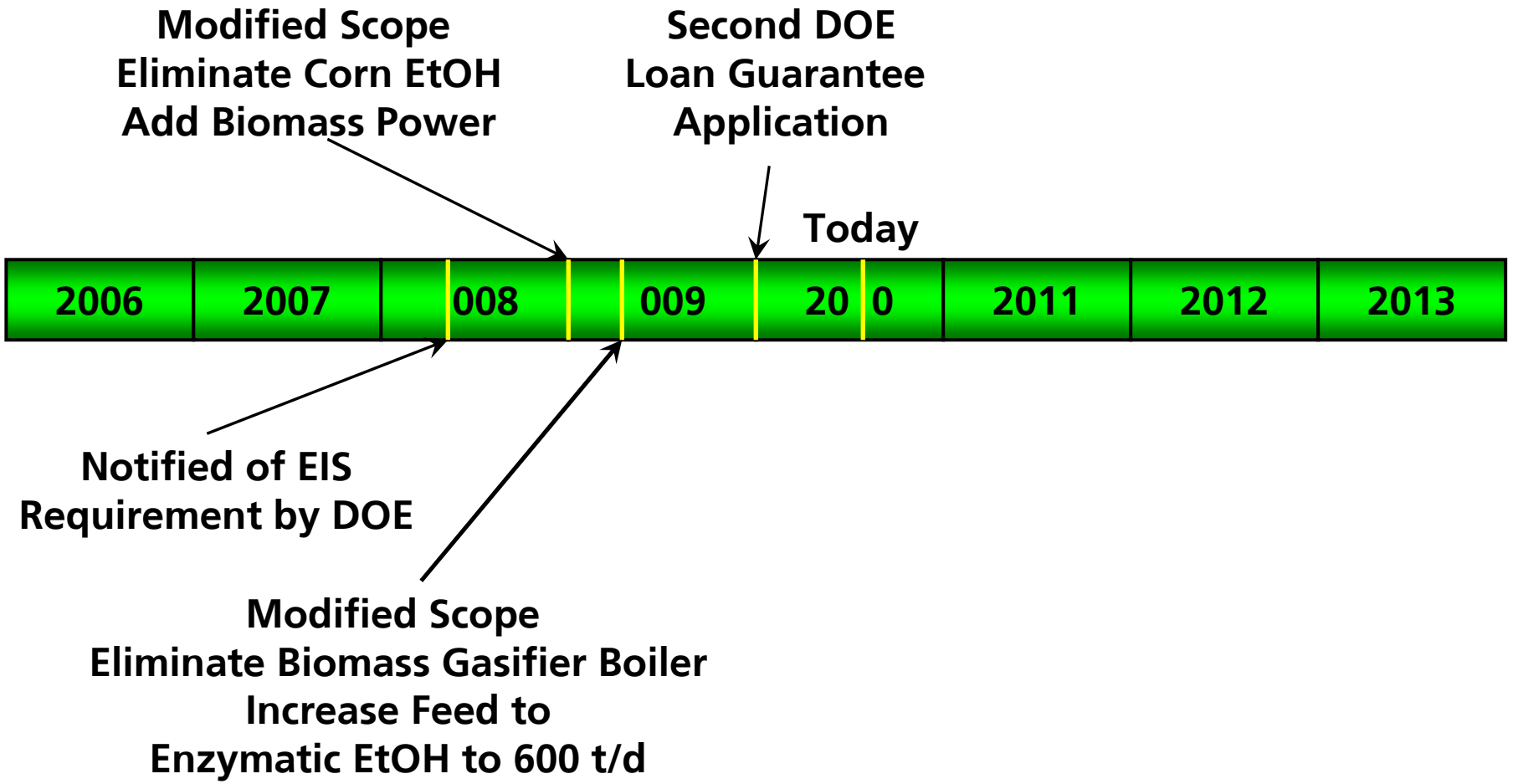

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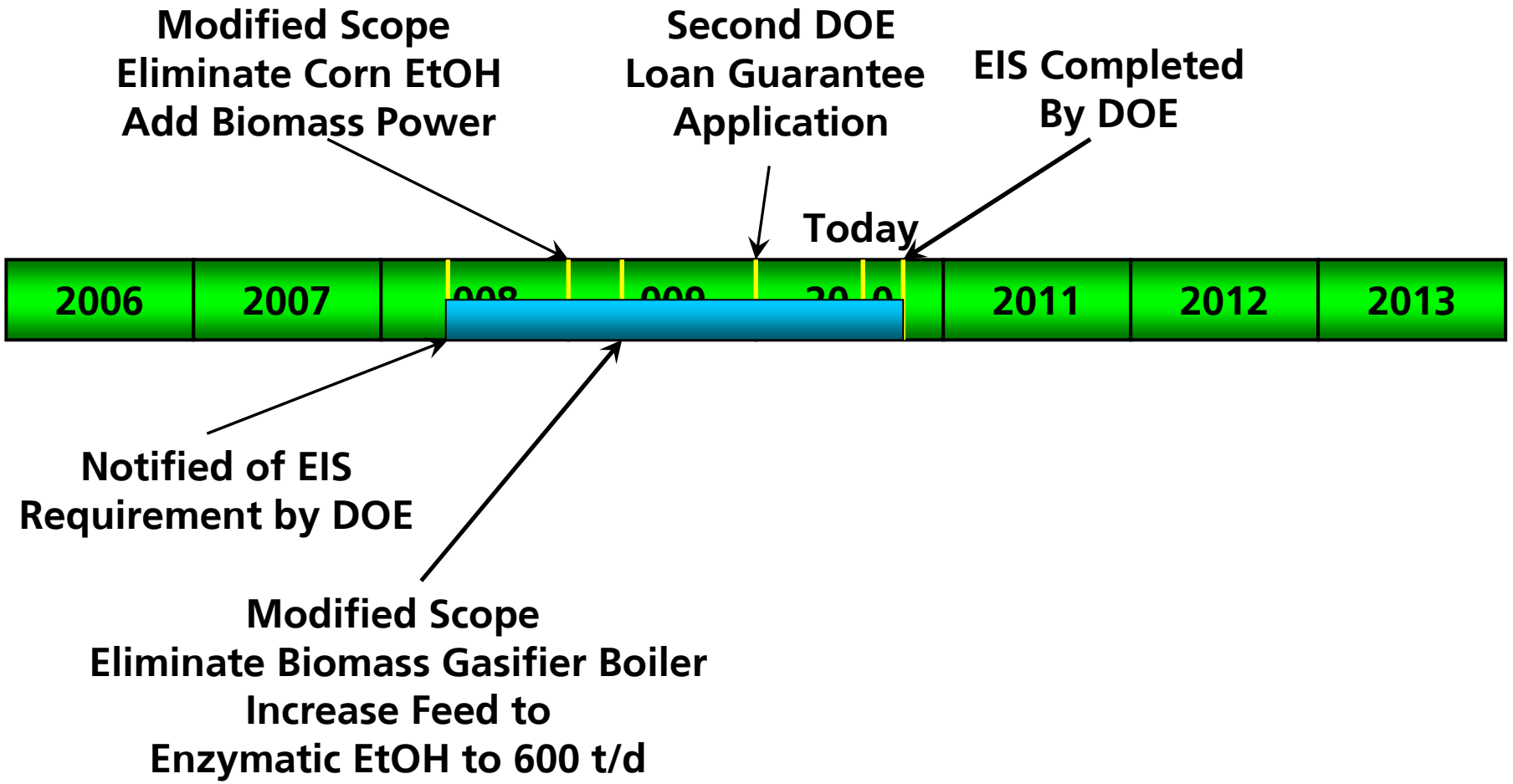

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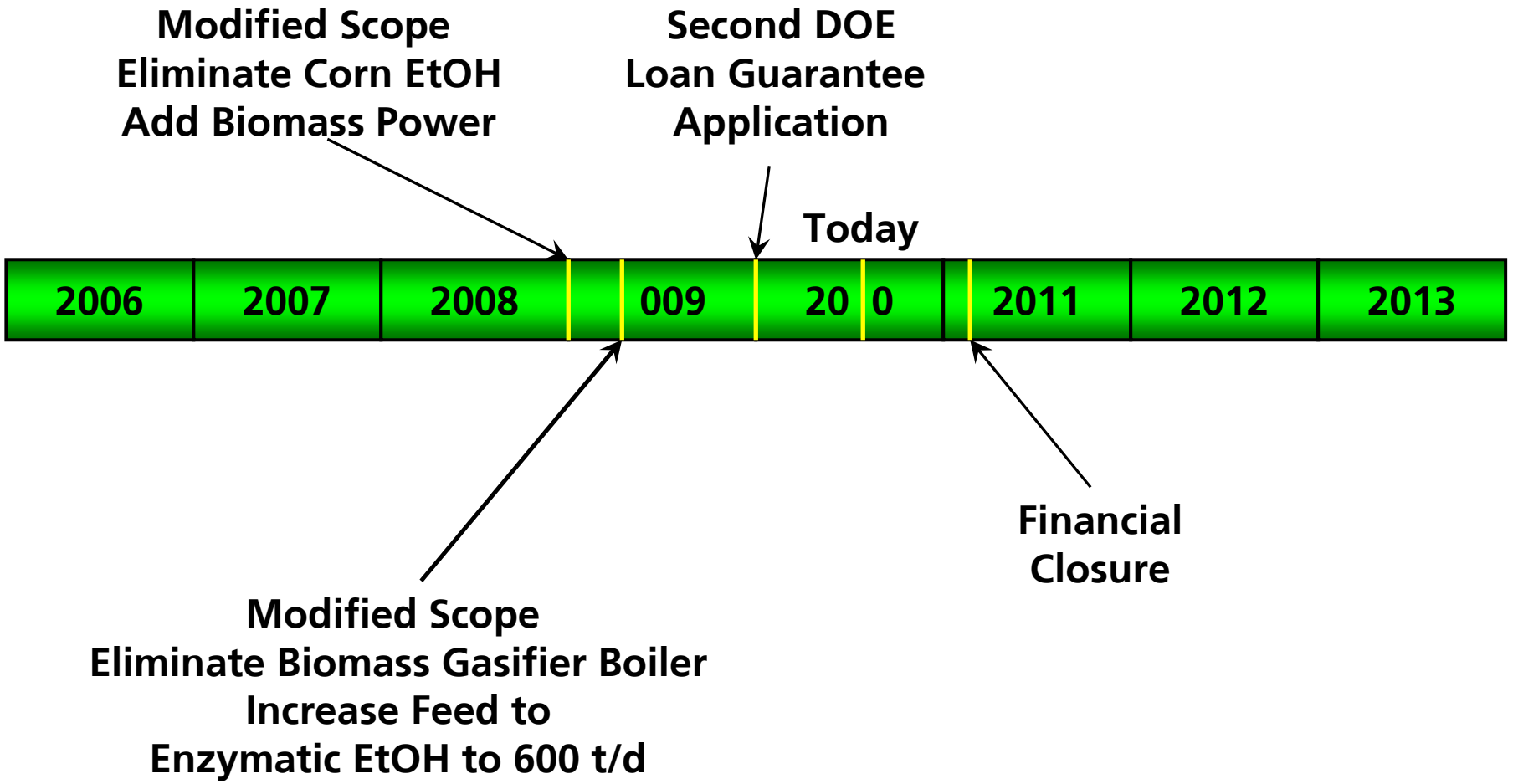

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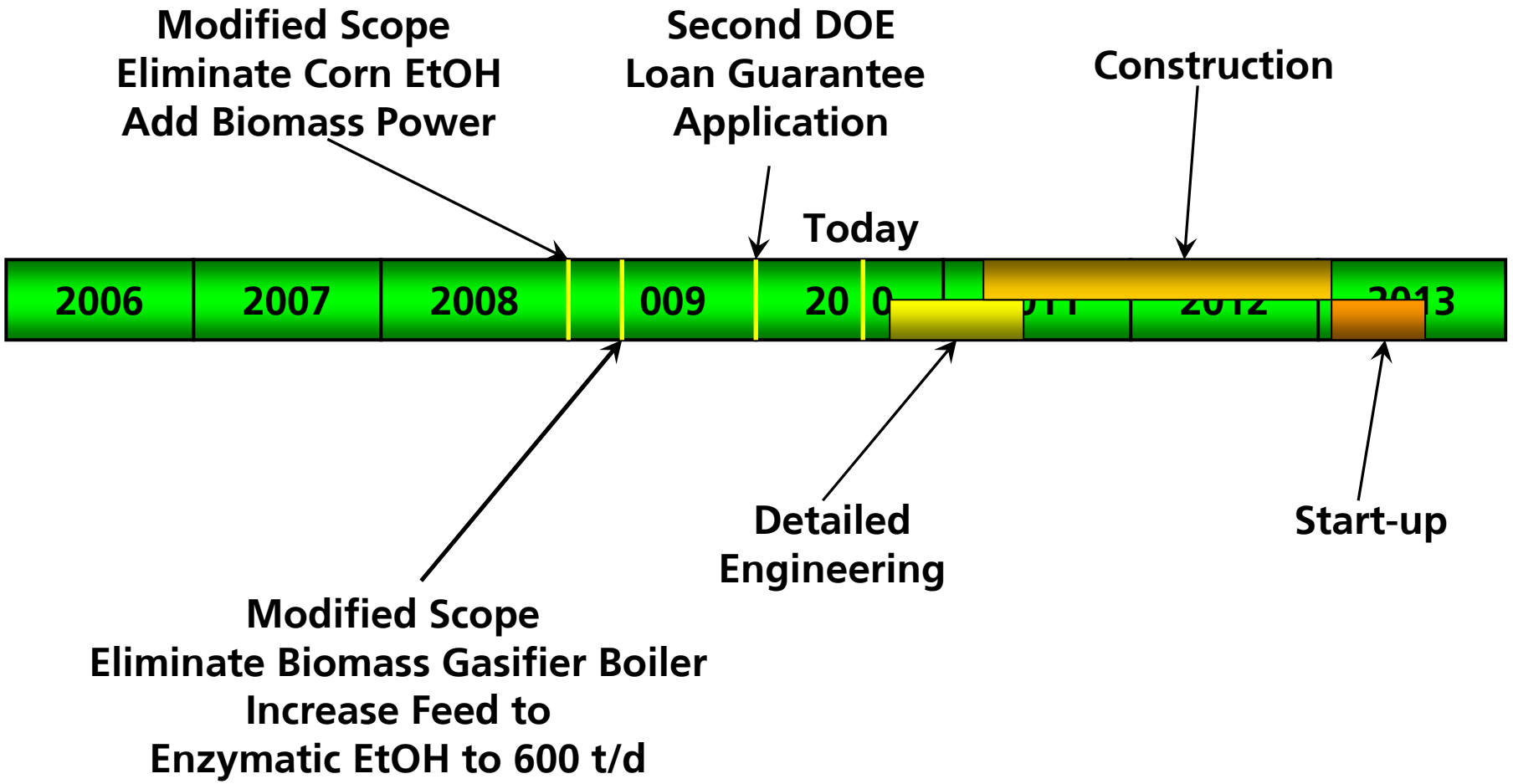

ABHK Site

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Hugoton Case

Enzymatic Hydrolysis Plant

EtOH

15 MMgal/year

Biomass Feedstock

600 tpd Biomass

1900 tpd Biomass

Electricity <25MW

Steam

Energy Plant

Renewable Electricity

>75MW

- ✓ 2,500 Dry Tons per day
- ✓ 875,000 Dry Tons per year
- ✓ Corn Stover, Wheat Straw, Switch Grass

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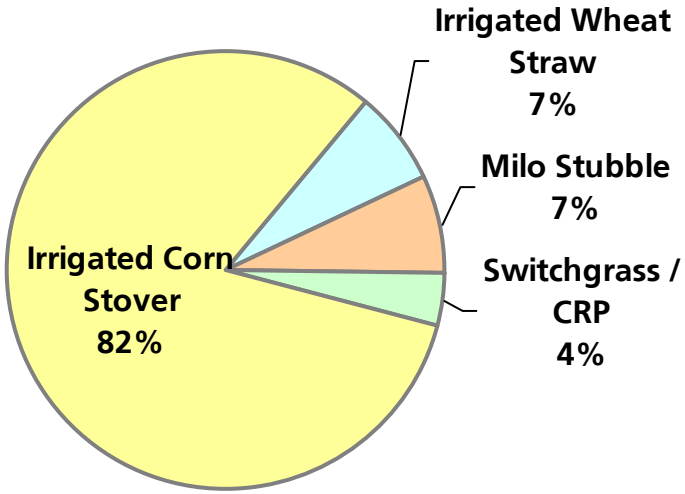
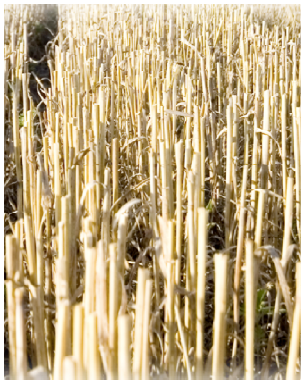
ABHK Biomass Feedstock Needs

- 875,000 "dry" tons of biomass per year
- Estimated 400,000 acres of land





Irrigated Wheat Straw

Milo Stubble

Switchgrass

Irrigated Corn Stover

CRP Grassland

Hugoton Case (Cont)

ABHK Project Schedule

Done	✓ Site secured, water rights secured, all major permits in process ✓ Financing efforts started, financial advisor engaged ✓ DOE Loan Guarantee Part 1 application submitted ✓ Power Purchase Agreement Term Sheet Executed	Completed
Done 2010	✓ Secure Power Purchase Agreement ✓ Secure Biomass supply commitments ✓ DOE Loan Guarantee Part 2 application submitted ✓ Completed the Preliminary Engineering Design ✓ Signed EPC Agreement	Completed
2H 2010	✓ Substantial Completion Detailed Engineering ✓ Complete NEPA Environmental Impact Statement ✓ Secure Air and Water Permits ✓ Close Loan Guarantee and Financing ✓ Construction Begins	Pending
2012 13	✓ Construction Complete ✓ Plant Start Up	Pending

Hugoton Highlights

- Enzyme production Strategy:
  - Negotiating toll manufacturing agreements to produce with Dyadic technology
  - Alternatives
    - DSM partnership
    - Novo/Genencor supply
- Biomass procurement, harvest and logistics.
  - 65% of biomass needs under contract
  - Confirming harvesting and logistics assumptions with field testing this fall
  - Supply flexibility includes using wood chips for boiler feedstock
- Electricity offtake
  - 20 year offtake agreement with Mid Kansas
  - Fixed pricing
  - Buyer obligated to purchase 100% of power produced
  - REC's and all other environmental attributes excluded
- C_5 sugar fermentation
  - Cargill strategic partnership pending
- Ethanol offtake
  - ABT to market all cellulosic ethanol produced

Improvements still Needed to make cellulosic ethanol cost effective and competitive with grain ethanol

- Process
  - Cost effective enzymes
  - C_5 to ethanol organisms
  - Fractionation process
  - Plant design and operational learning curve

- Feedstock
  - High density balers
  - One-pass energy efficient harvesting systems
  - Storage infrastructure and systems to maintain quality (on and off site)
  - Improved genetics of feedstock varieties
  - Transportation infra-structure and biomass friendly regulations

Conclusions

- Commercial cellulosic bioethanol is an Abengoa Bioenergy goal.
- Our Pilot & Demonstration plants provide us with information for:
  - Technology optimization.
  - Investment reduction in future construction plants.
  - Operational cost reduction.
  - Enzyme testing and optimization.
- Biomass procurement and logistic strategies are a key to commercial viability.

Thank you

www.abengoabioenergy.com

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