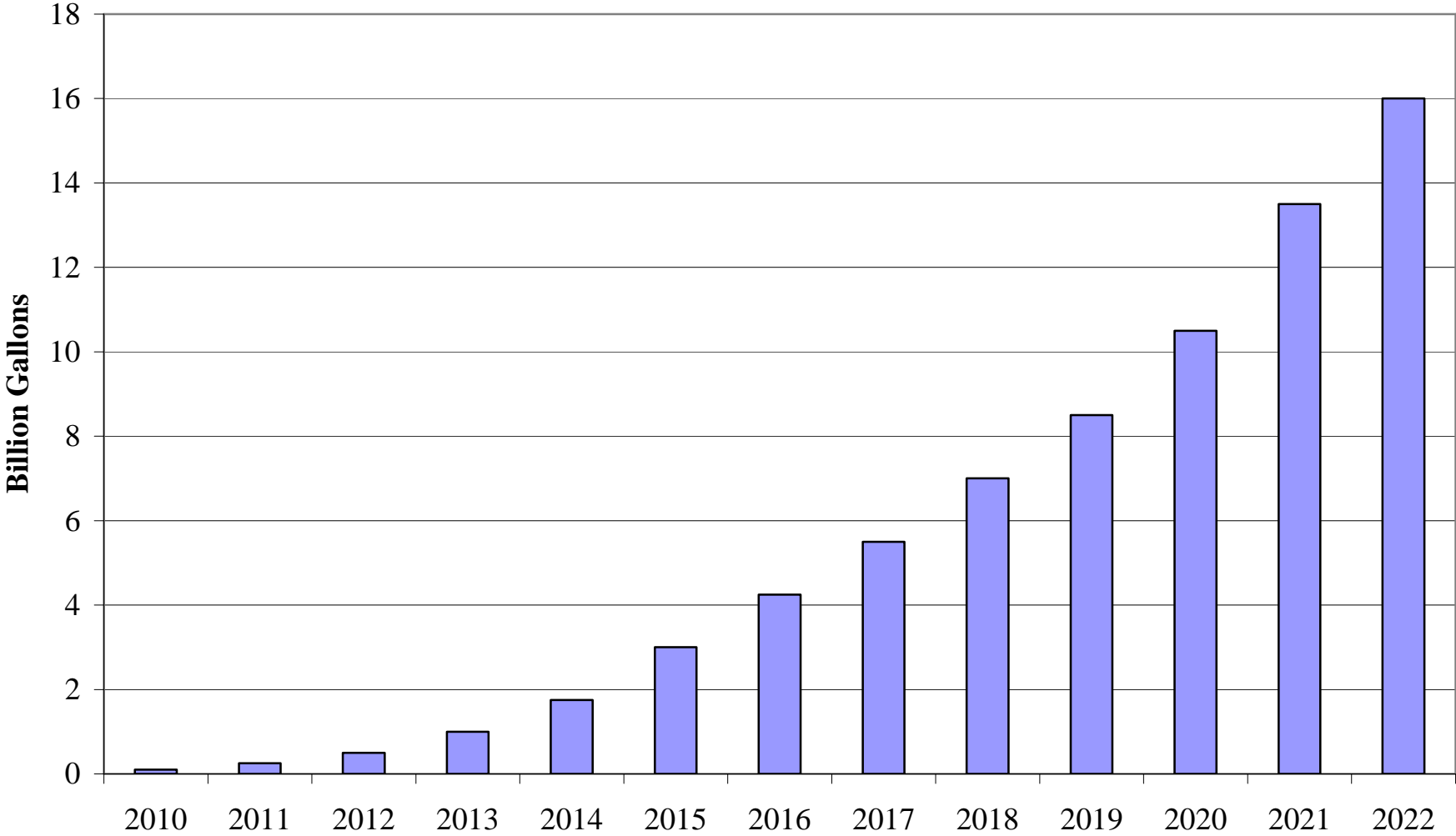


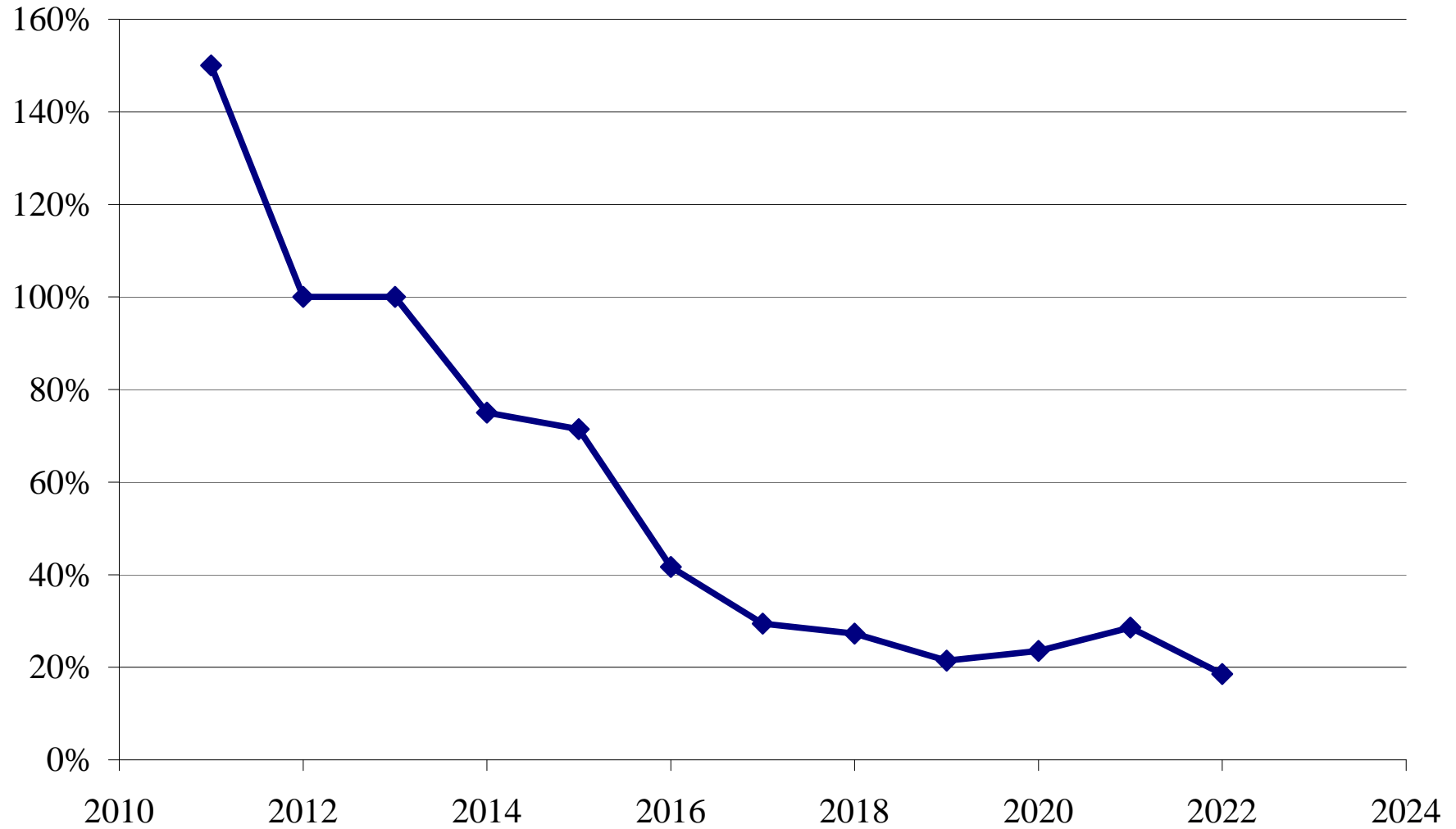
Role of the RFS in Inducing Investment in Cellulosic Biofuels Refineries

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Iowa State University

EISA Mandates for Cellulosic Biofuels



Annual Growth Rates in Cellulosic Mandates



Obstacles to Achieving Mandate

- If cellulosic ethanol, who can use it?
- Who has \$60 billion to invest in a commodity business?
- Will increased carbon price cause biomass to flow to generating electricity?
- Will future cars use biofuels or electricity?

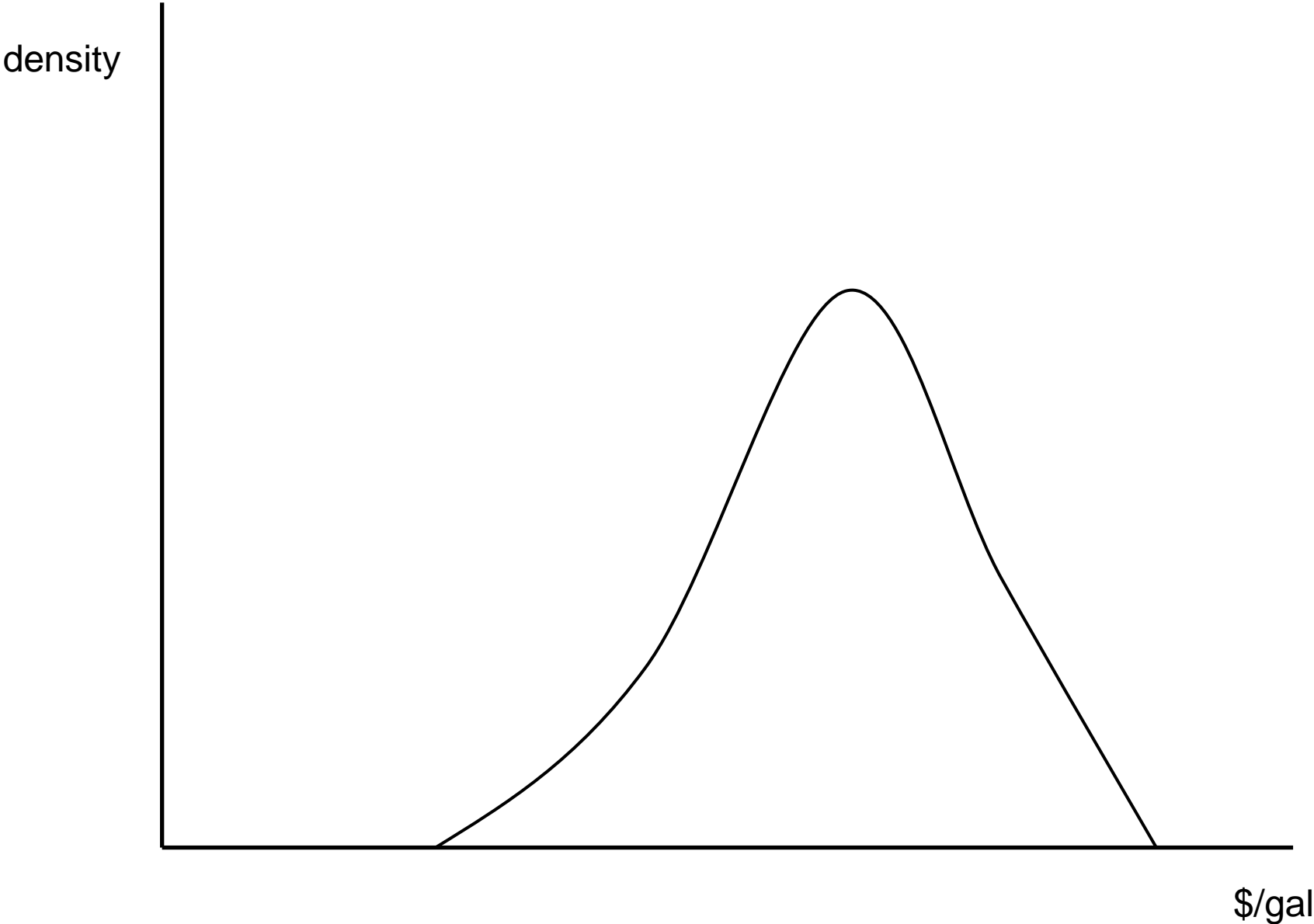
Assume all these obstacles disappear.

Will the RFS induce investment?

A Simple Investment Model

- First consider cellulosic biofuels investment decision without a mandate as a benchmark
- We have two time periods. The present and the future.
- Each potential investor has a technology that can produce cellulosic at a different per gallon production (variable) cost
- Capital costs are the same across investors

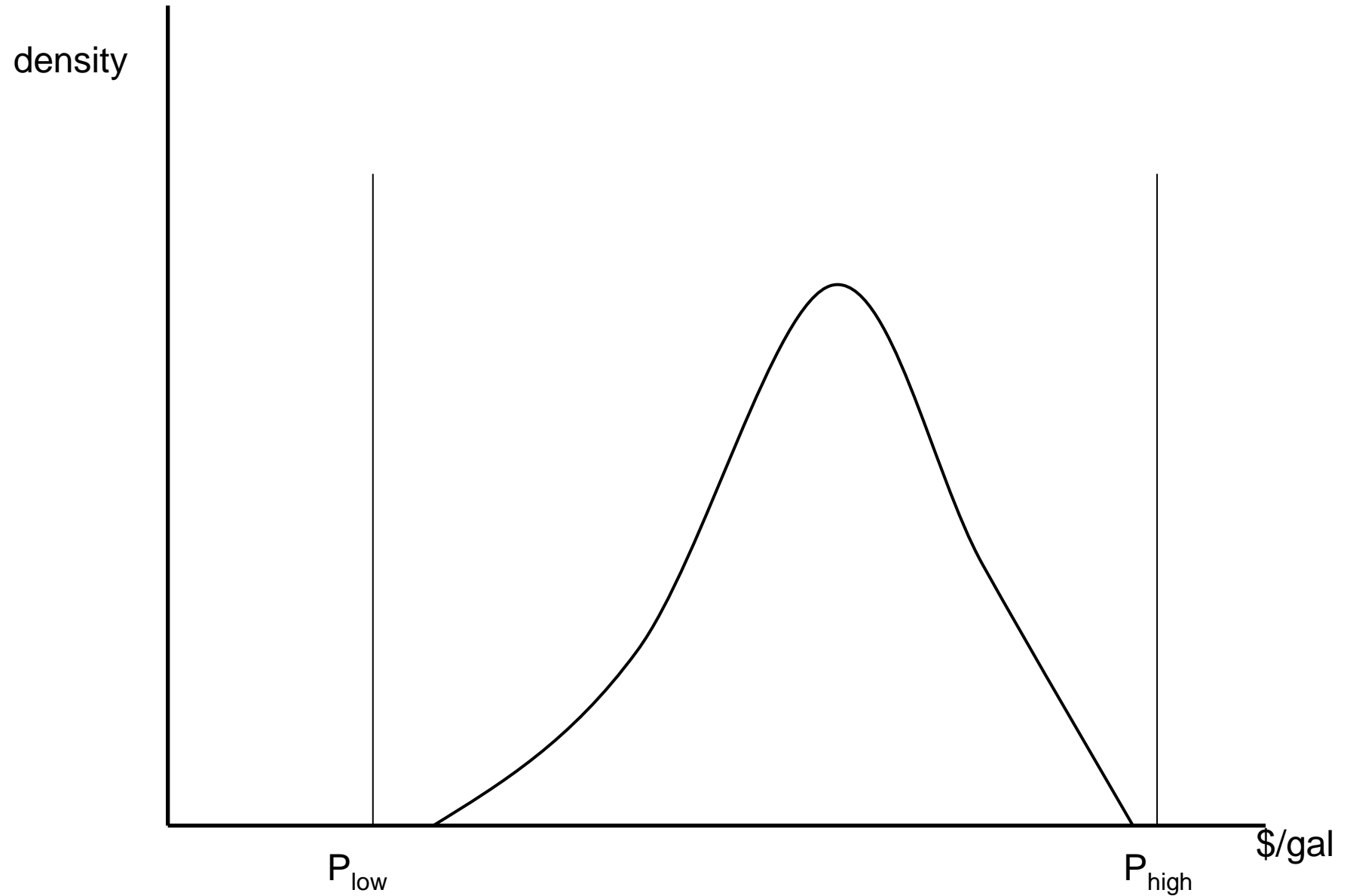
Distribution of Production Costs Across All Potential Investors



Investor Decision

- Can invest today or can wait to see what future brings in terms of price of biofuels.
- Future:
 - Costs are the same as today
 - Price of biofuels is either “high” or “low”
 - High price induces investment
 - Low price does not cover production costs

Potential Investment Opportunity in the Future



Investment Decision Today

- If invest today, receive today's price and either a high price or a low price tomorrow.
 - If high price keep operating
 - If low price, shut down plant

- Two period profit =

$$(\text{Price today} - \text{VC}) + q^*(P_{\text{high}} - \text{VC}) - \text{FC}$$

Variable cost

Probability of a high price

Fixed cost

Investment Decision Tomorrow


- Invest tomorrow if high price occurs, don't invest if low price occurs.
- Expected Profit in the future =
 $q^*(P_{\text{high}} - VC - FC)$

Decision Rule


- Invest today if

$$\text{Price Today} - VC > (1-q)*FC$$

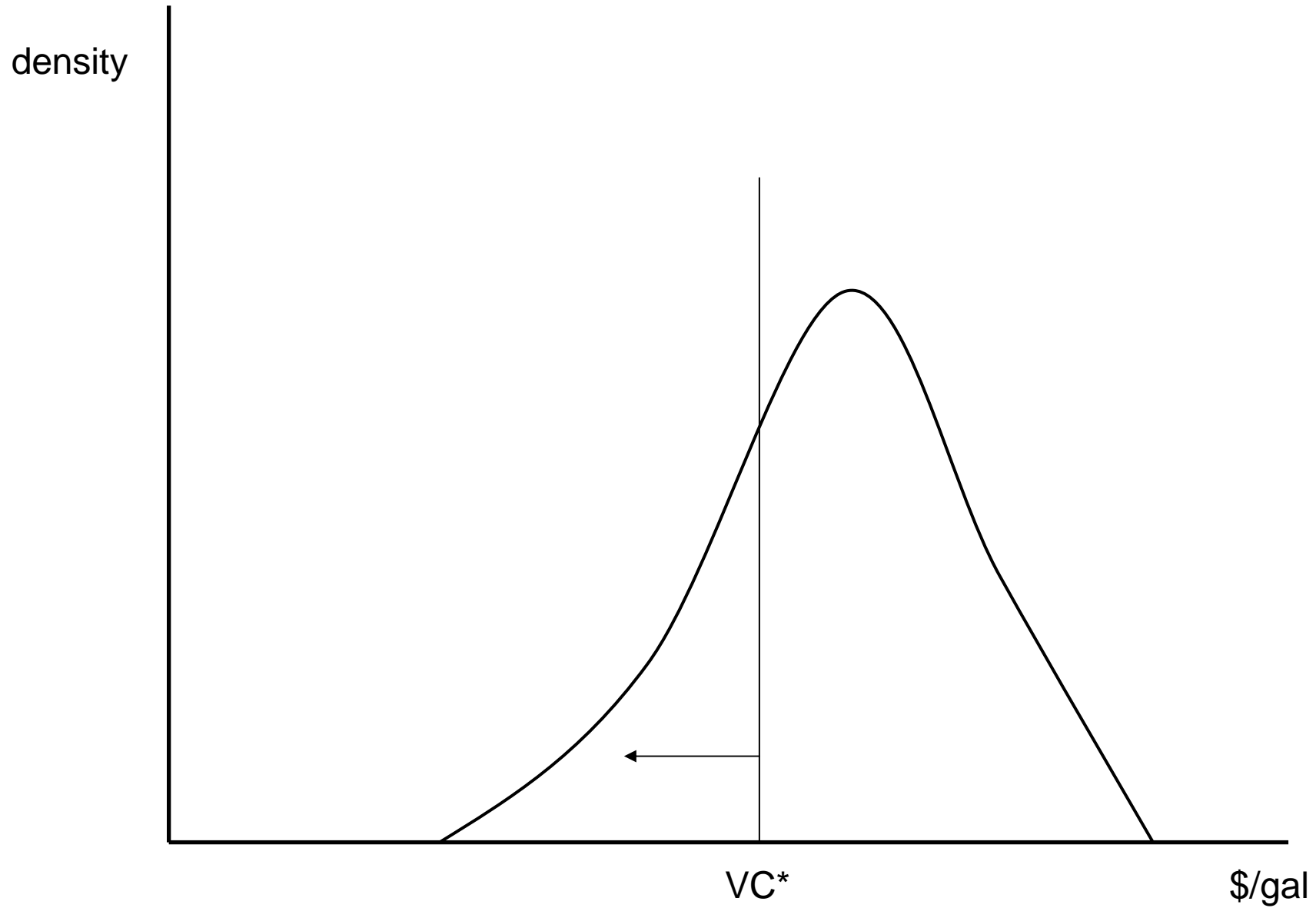
Benefit of positive
margin today



Loss of capital due to not
waiting to see if low price
occurs in the future



Marginal Investor: $VC^* = \text{Price Today} - (1 - q) \cdot FC$



Impact of a Future Mandate on Investment

- If aggregate production for all plants with $VC < VC^*$ is greater than the mandate, then the mandate has no impact on investment
- So assume that the mandate binds in the future so that VC of the plant that is needed to meet the mandate $> VC^*$

Impact of a Binding Mandate

- In the future, if the price is high, then mandate will not bind
- If the price is low then mandate will bind.
- Profit to an investor in future when price is low:

$$P_{\text{Low}} + P_{\text{RIN}} - VC - FC$$

Price of Renewable
Identification Number



What Will be the Price of RIN?

- To drive investment in the future, the price of RIN will have to be high enough to cover fixed and variable costs of the marginal plant:

$$P_{\text{RIN}} = P_{\text{Low}} - VC^{**} - FC$$

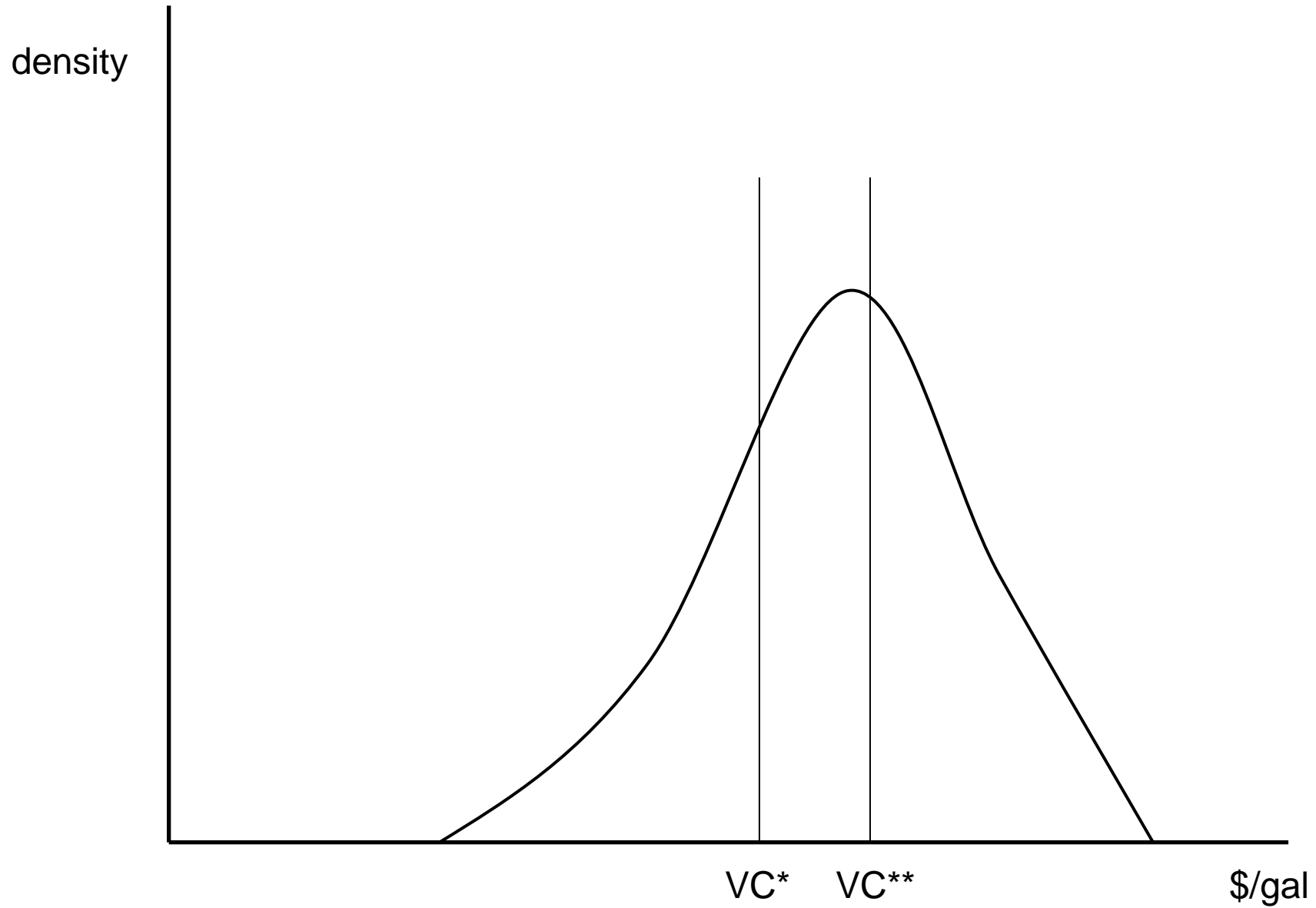
Positive RIN Price in the Future Decreases Risk of Investment Today

- If the mandate tomorrow is greater than the level of investment today, then the decision rule for investment today is to invest if

$$\text{Price Today} - VC > 0.$$

Marginal Investor: $VC^* = \text{Price Today} - (1 - q) \cdot FC$

$VC^{**} = \text{Price Today}$



What Did We Show?

- A future mandate provides a guarantee that fixed cost of the marginal plant will be covered.
- Hence, the fixed cost of all plants with lower variable costs will also be covered
- Thus the benefit of waiting to see if future profitability is high enough to justify investment is gone.
- So more investment today

However: Page 35 of EISA says

“Cellulosic Biofuel: For any calendar year for which the projected volume of cellulosic biofuel is less than the minimal applicable standard....., The Administrator shall reduce the applicable volume of available during that calendar year.”

Mandate with Waivers

- If capacity of industry is less than the mandate, no way of meeting the mandate.
- Administrator reduces mandate to capacity to produce.
- $P_{RIN} = P_{Low} - VC^*$
- Note: Price of RIN does not cover fixed costs

- Proposition 2. If the mandate comes along with waivers, the equilibrium investment level in period one is unique and equal to the equilibrium investment level in period one when there is no mandate. That is the mandate with waivers does not have any effect on the investment level in period one.

Conclusions

- RFS with waivable mandate does not induce investment
- Tax credit for cellulosic biofuels does induce investment
- If the U.S. is serious about meeting advanced biofuels mandates, and current prices will not generate profits, then direct investment subsidies are needed.