Electricity Markets

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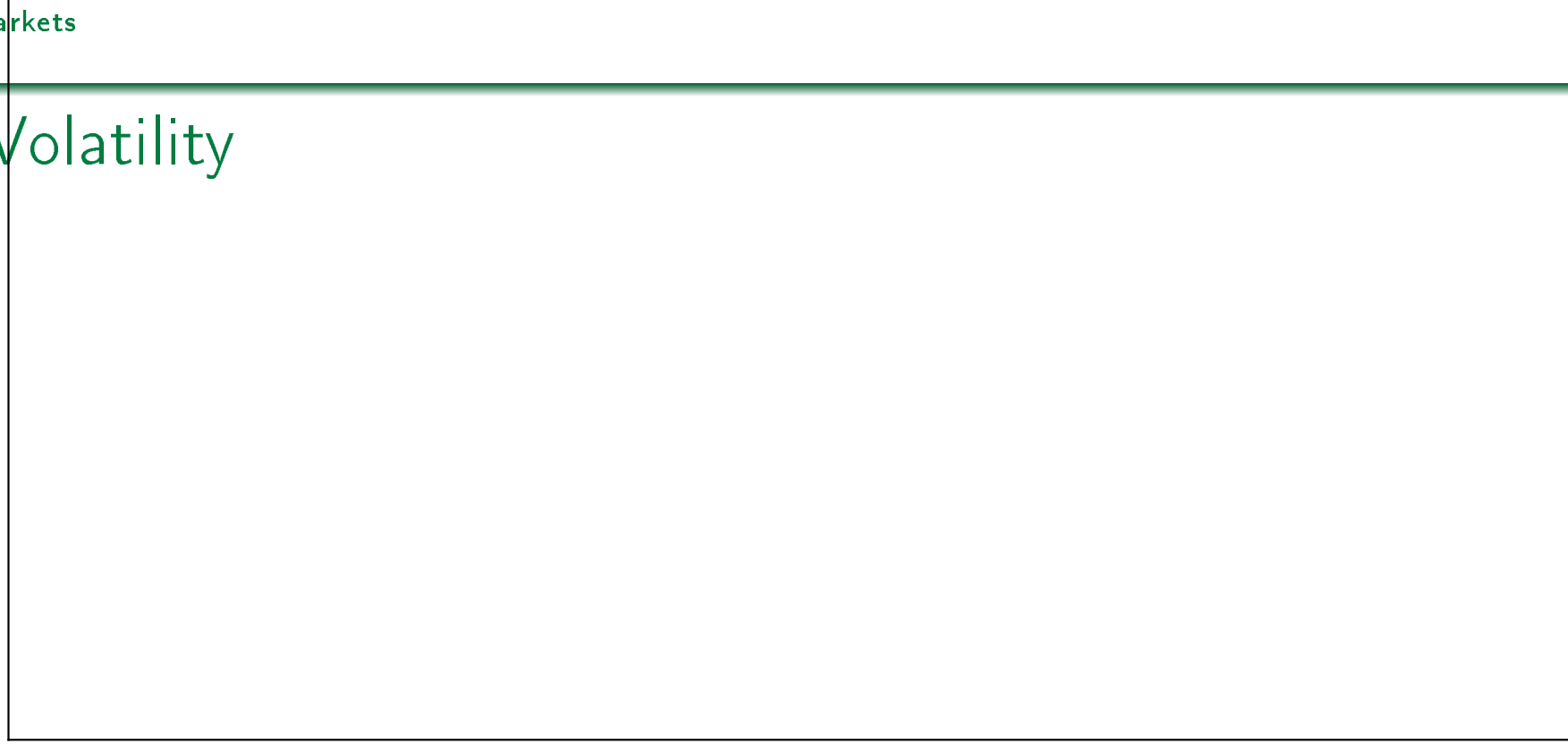
Why should you care about electricity?

- Price volatility:
  - Electricity prices are an order of magnitude more volatile than oil or gas prices
  - Both supply and demand in Alberta affect us more than global or regional supplies and demands in oil and gas markets
- New technology:
  - Electricity is, arguably, changing faster than any other energy market
  - Alberta's electricity market is entering a period of market- and regulatory-driven transition
- Economics 101 in action
  - Nowhere else will you see supply and demand curves actually mapped out in real time determining prices as clearly as in Alberta's power market

Price Volatility



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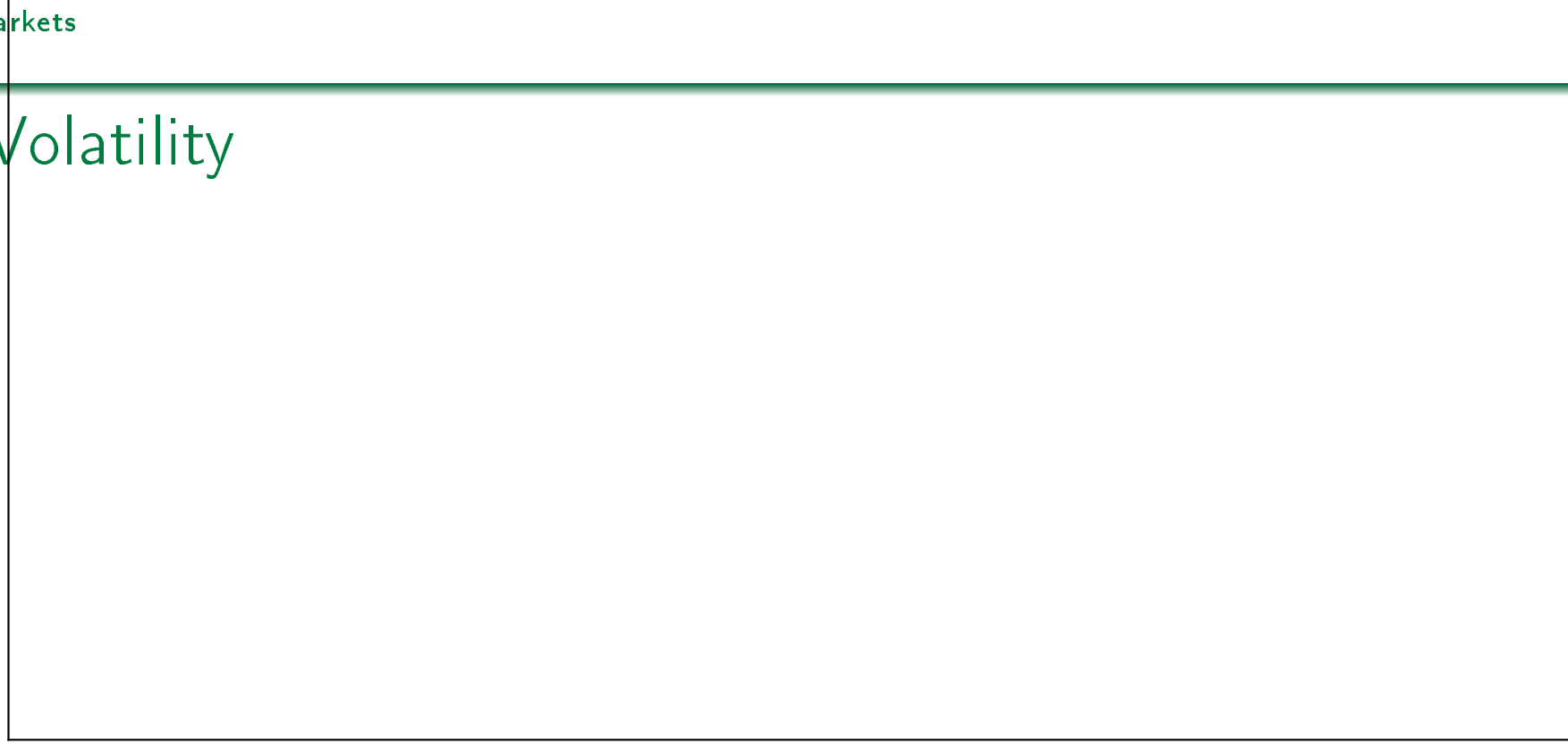

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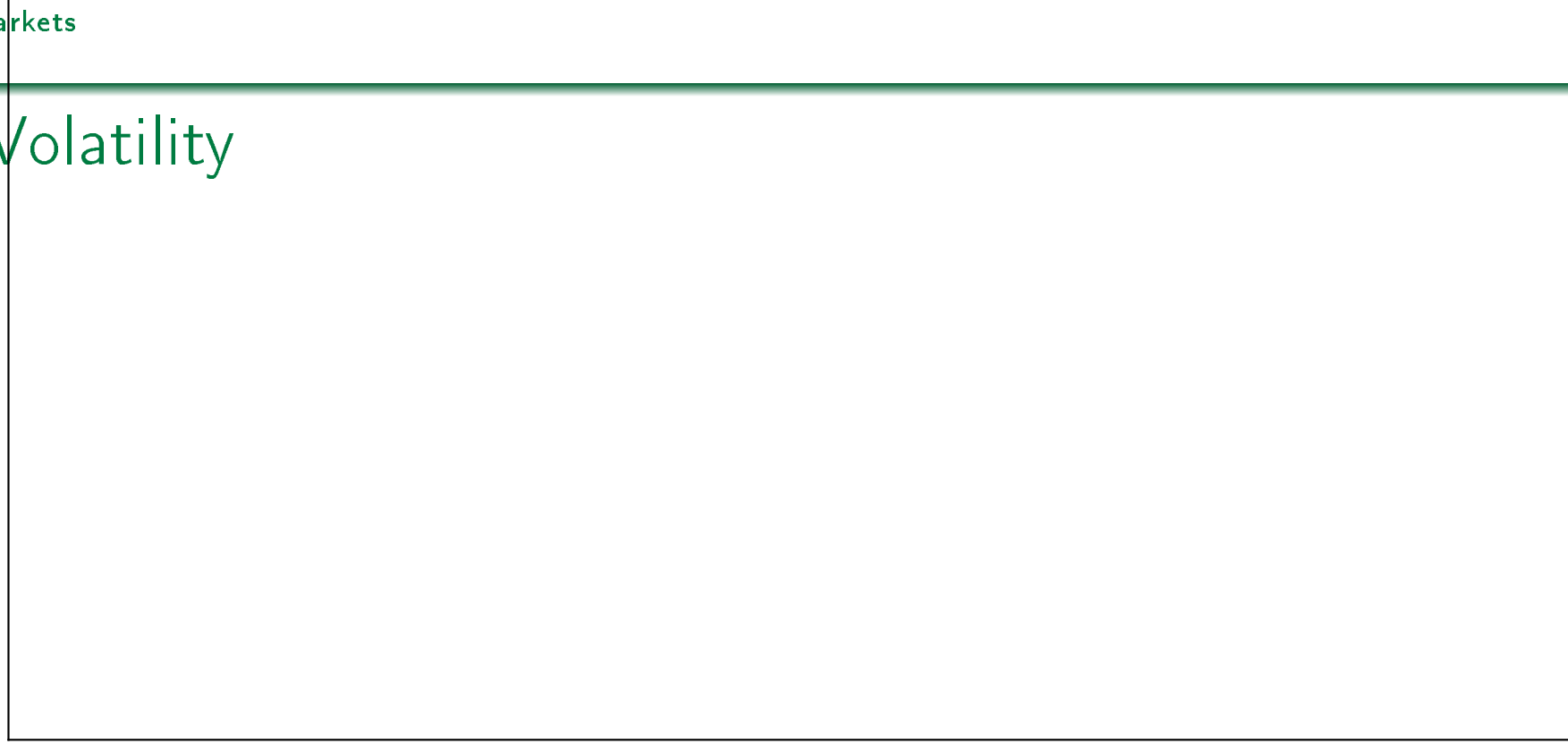
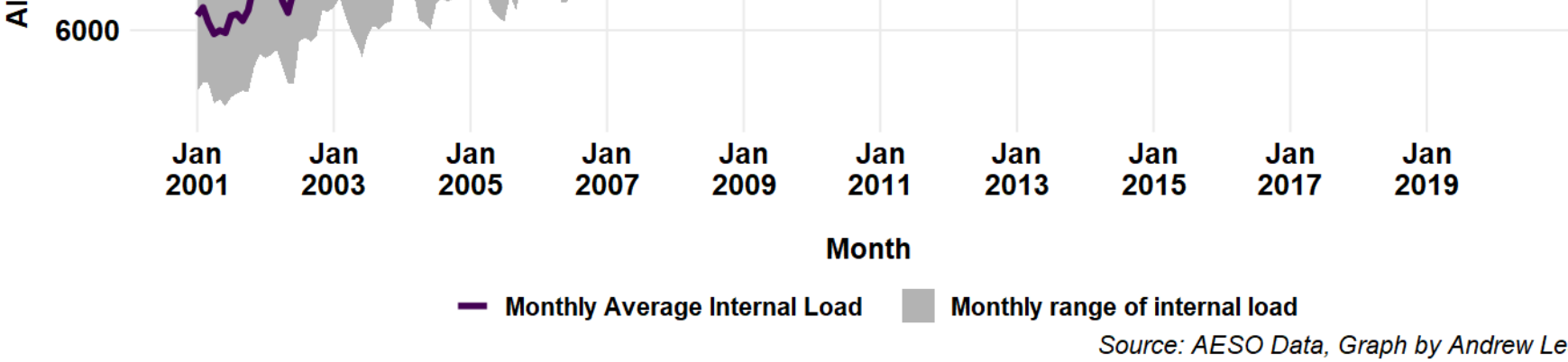
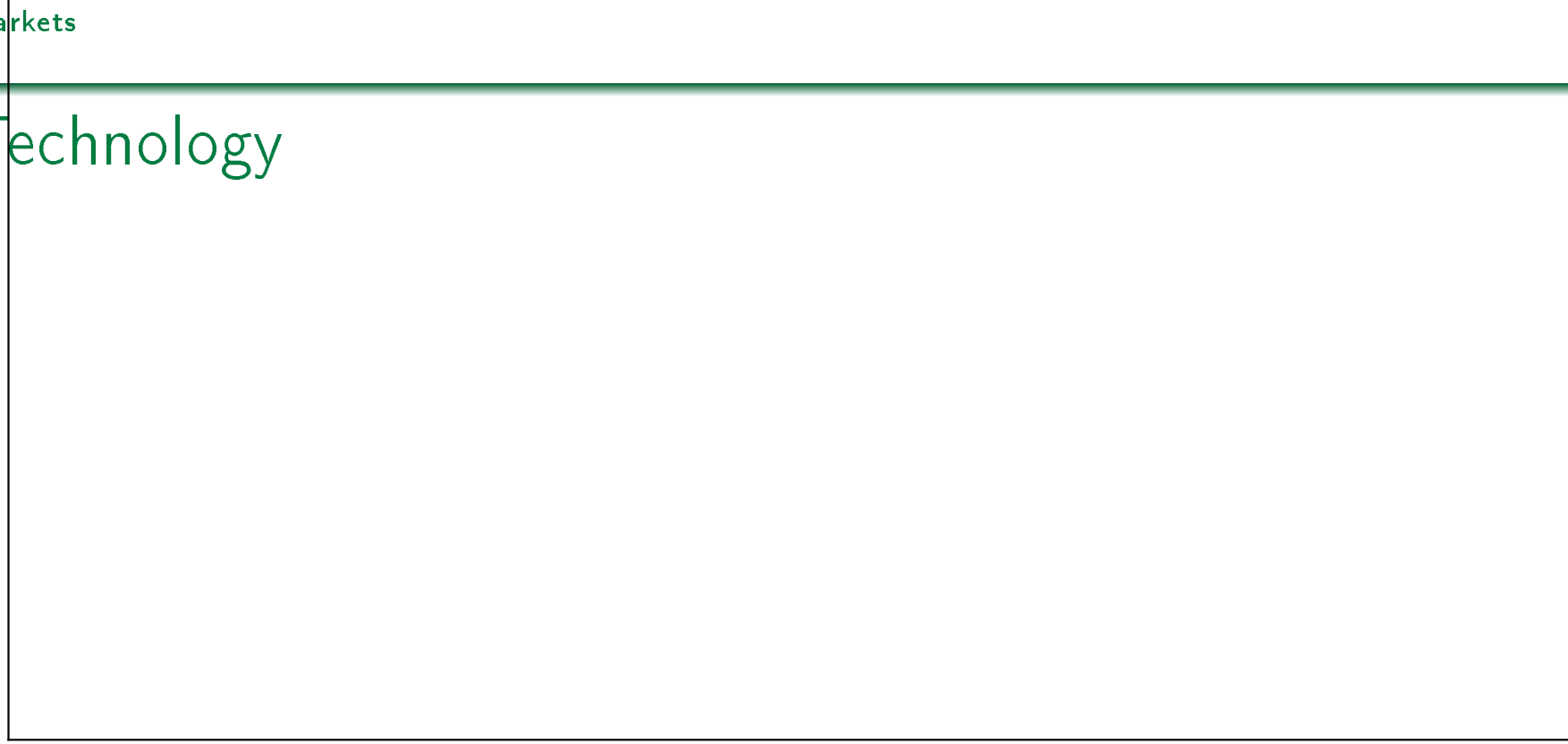


Growth



Source: AESO Data, Graph by Andrew Le

New Technology



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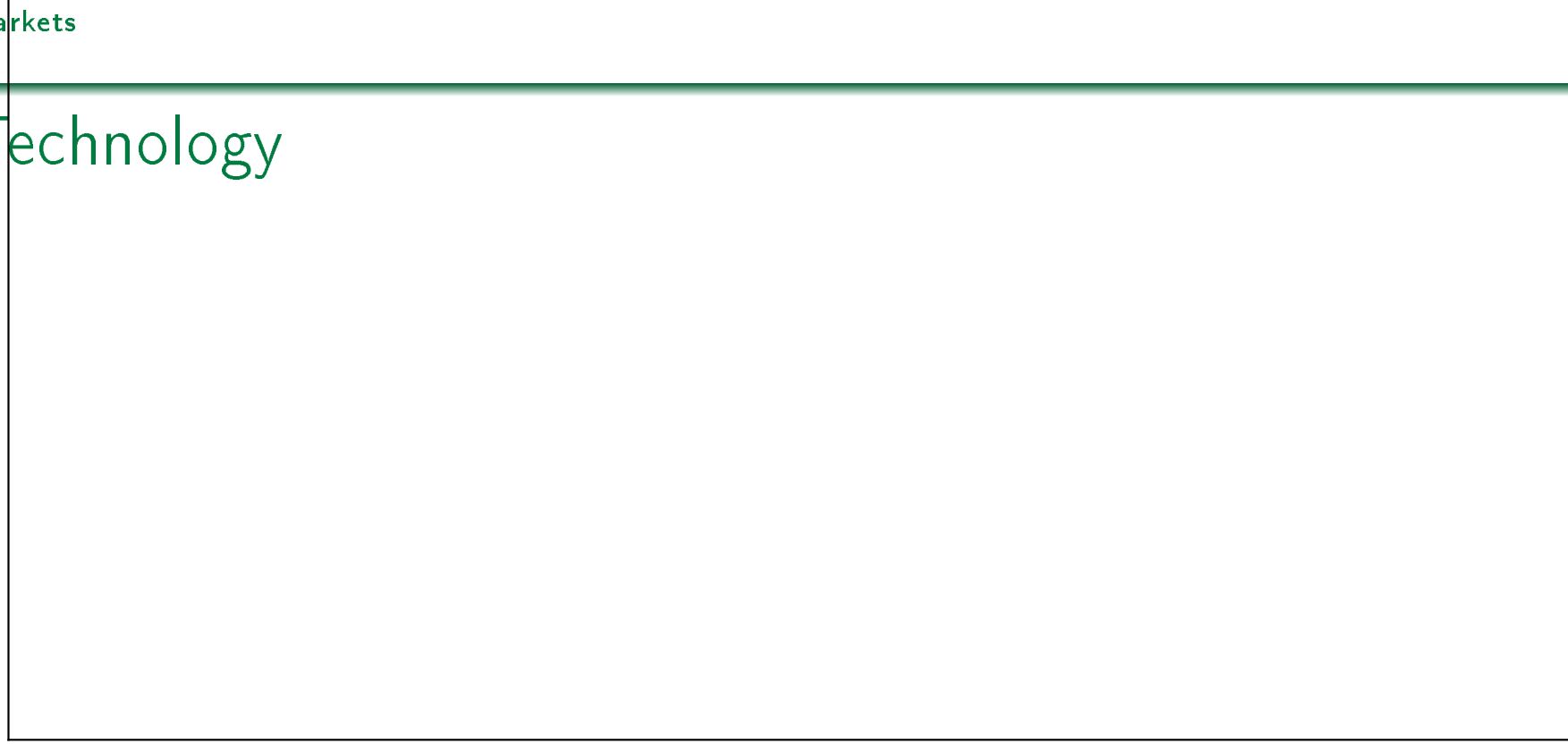
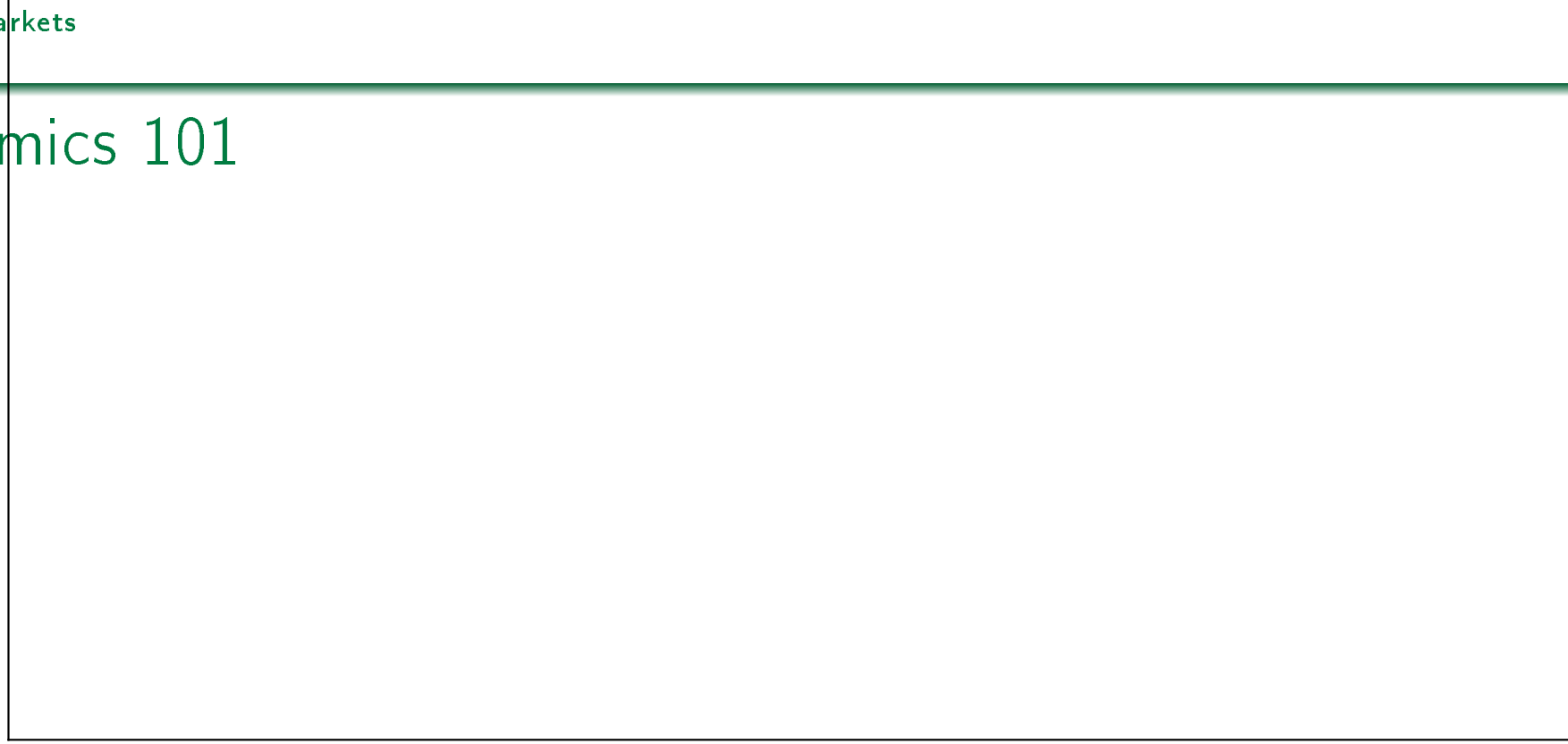
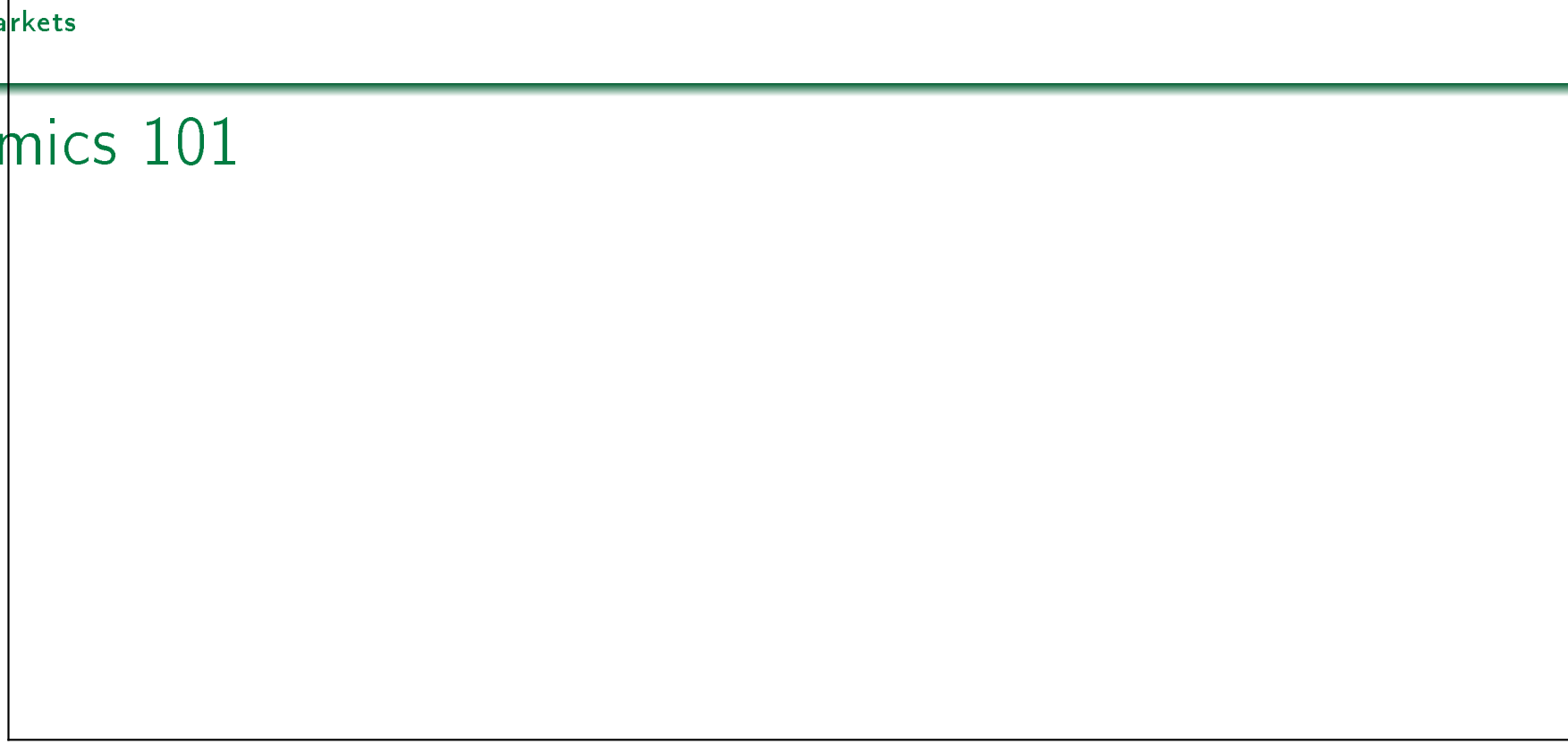


Economics 101



Economics 101



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Market Participants

- Generation
- Transmission
- Distribution
- Ancillary Services
- Load
- Storage
- Microgeneration

Energy units - electricity

- Watts: measure of capacity (instantaneous production, installed capacity, or instantaneous demand)
  - Alberta system demand: 7,200-10,700 MW (million watts)
  - Capital Power's Genessee 3 power plant has a nameplate capacity of 450 MW
- Watt hours: measure of energy (production or demand during a given period of time; i.e. flow through)
  - Production over a day, week, month, year
- Volts: measure of the electrical potential or the ability to convert charge to power (Watts=amps x volts)
  - Transmission lines: 150-765 kV
  - Distribution lines: 13,800 Volts
  - Household wiring: 120-240 Volts

Energy Prices

- Electricity prices: expressed in power delivered over time
  - Cents/kilowatt-hour (c/kWh)
  - Dollars per megawatt-hour ($/MWh)
  - Levelized costs of electricity (supply costs) in $/MWh
- Capacity costs are expressed in a cost per megawatt or cost of capacity
  - Genessee 3 cost approximately $1.5 million/MW or $1.50 per watt to build
  - Solar panel prices have declined to now lie under $1/W of capacity
  - Balance of system costs imply that a solar system costs $2-3/W of installed capacity
- Other prices matter for electricity markets as well
  - Renewable energy credits (usually prices in $/MWh)
  - Emissions credits or permits ($/tonne)
  - Capacity payments ($/MW)
  - Air emissions permits or credits ($/tonne)

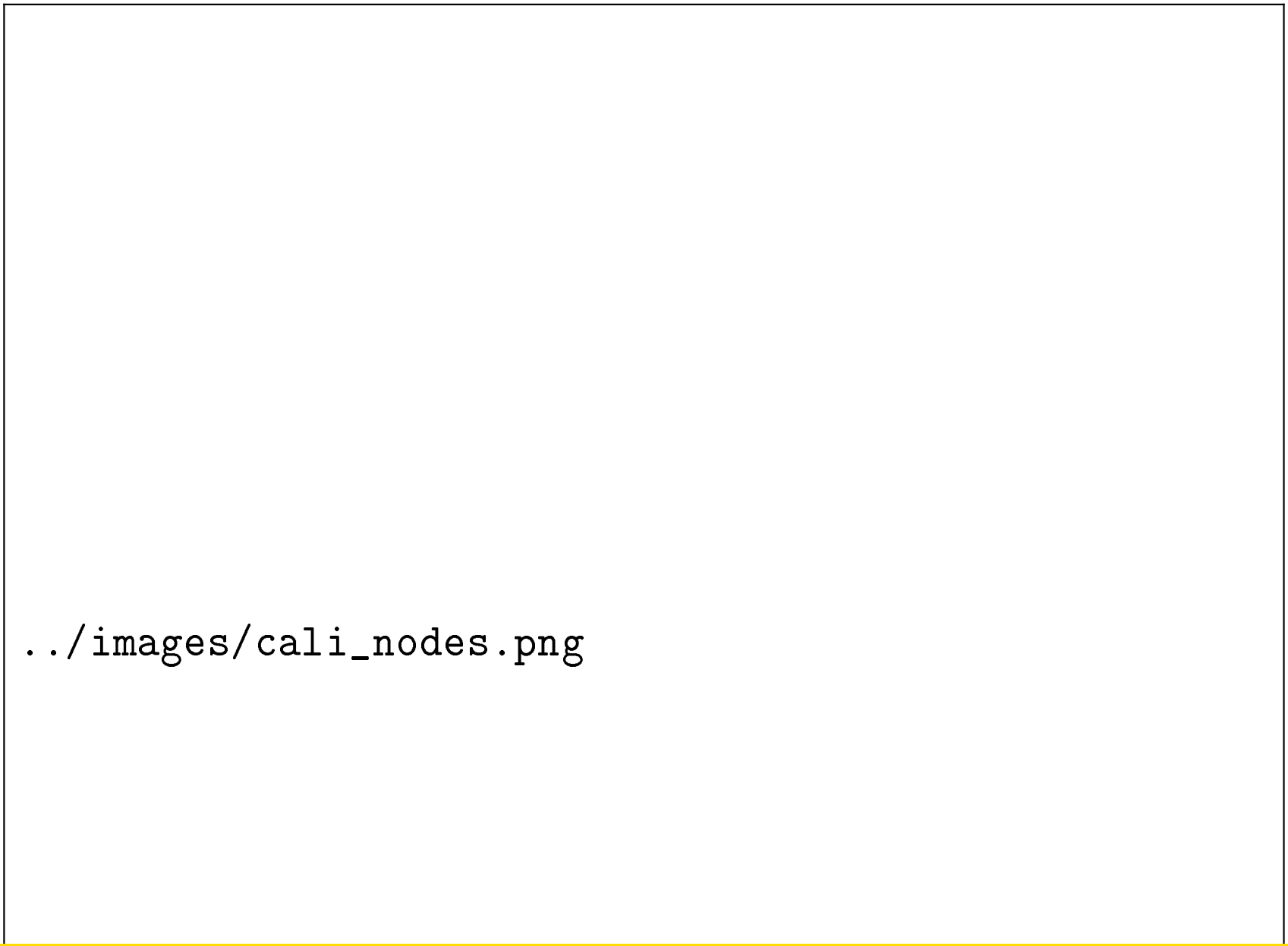
Regulatory characteristics

- Rate-regulated or or state-owned utilities
- Competitive markets
  - Energy only markets: ERCOT and Alberta
  - Energy and capacity markets: MISO, PJM, soon-to-be Alberta
  - Real-time vs day-ahead prices: PJM and others have day-ahead market and then a real time differences market
  - Many other design characteristic differences between restructured or competitive markets

Alberta Market Design

- Energy-only market
- Real time, spot pricing, no day-ahead market
- Single node
- Capacity market to be added in the near future
- Transmission
- Congestion free (no nodal pricing)
- No transmission rights
- Ancillary services: separate, competitive market for operating reserves, transmission-must-run, load-shed and black start

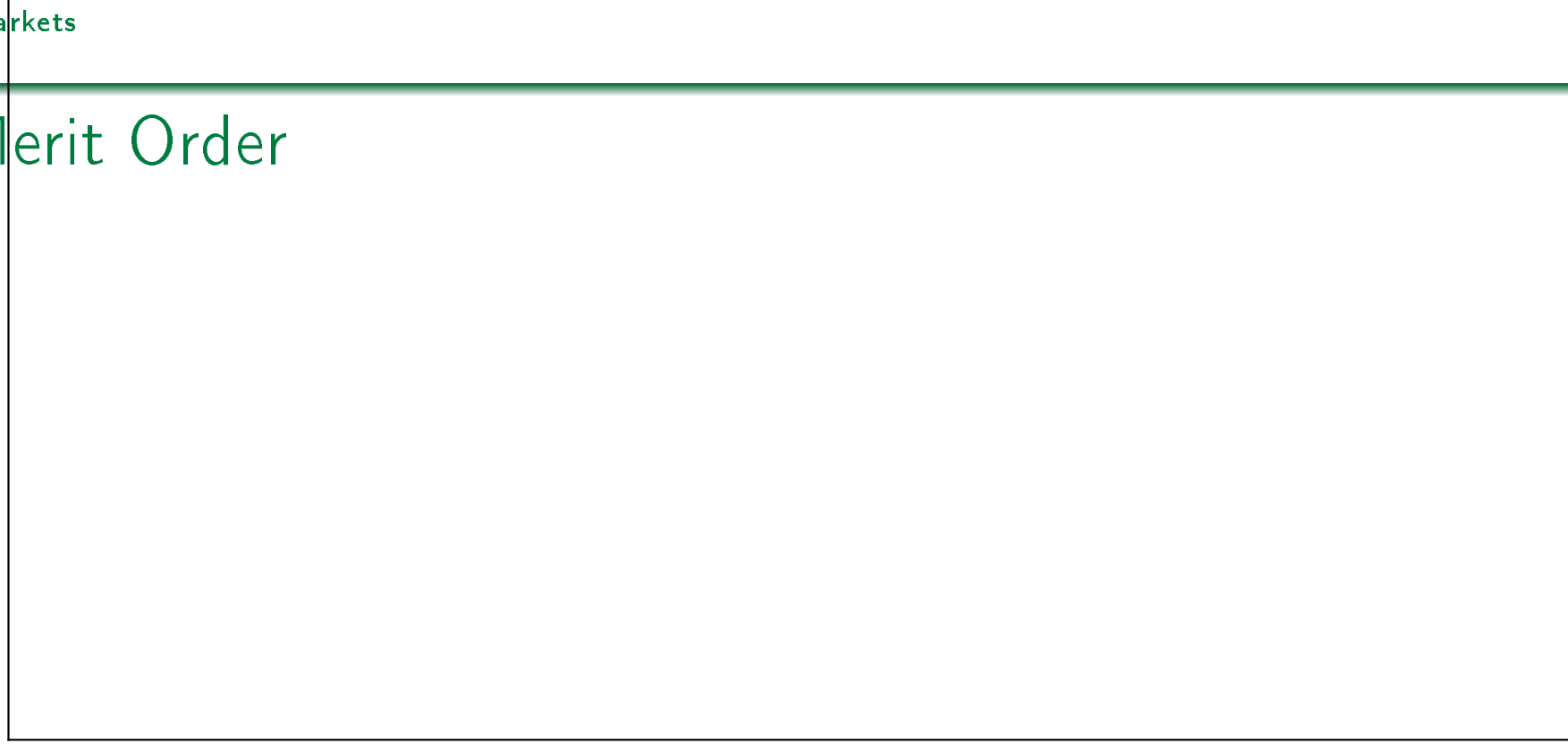
Nodal Pricing Example



The Wholesale Market

- Suppliers place offers of power at particular price
- Demand-side bids placed for power with a maximum price
- Supply offers are sorted from low to high
- Demand offers are sorted from high to low
- Marginal price is set at the price which equates supply and demand - economics 101 at work!
- Import supply is bid-in at $0, but receive the marginal price

The Merit Order



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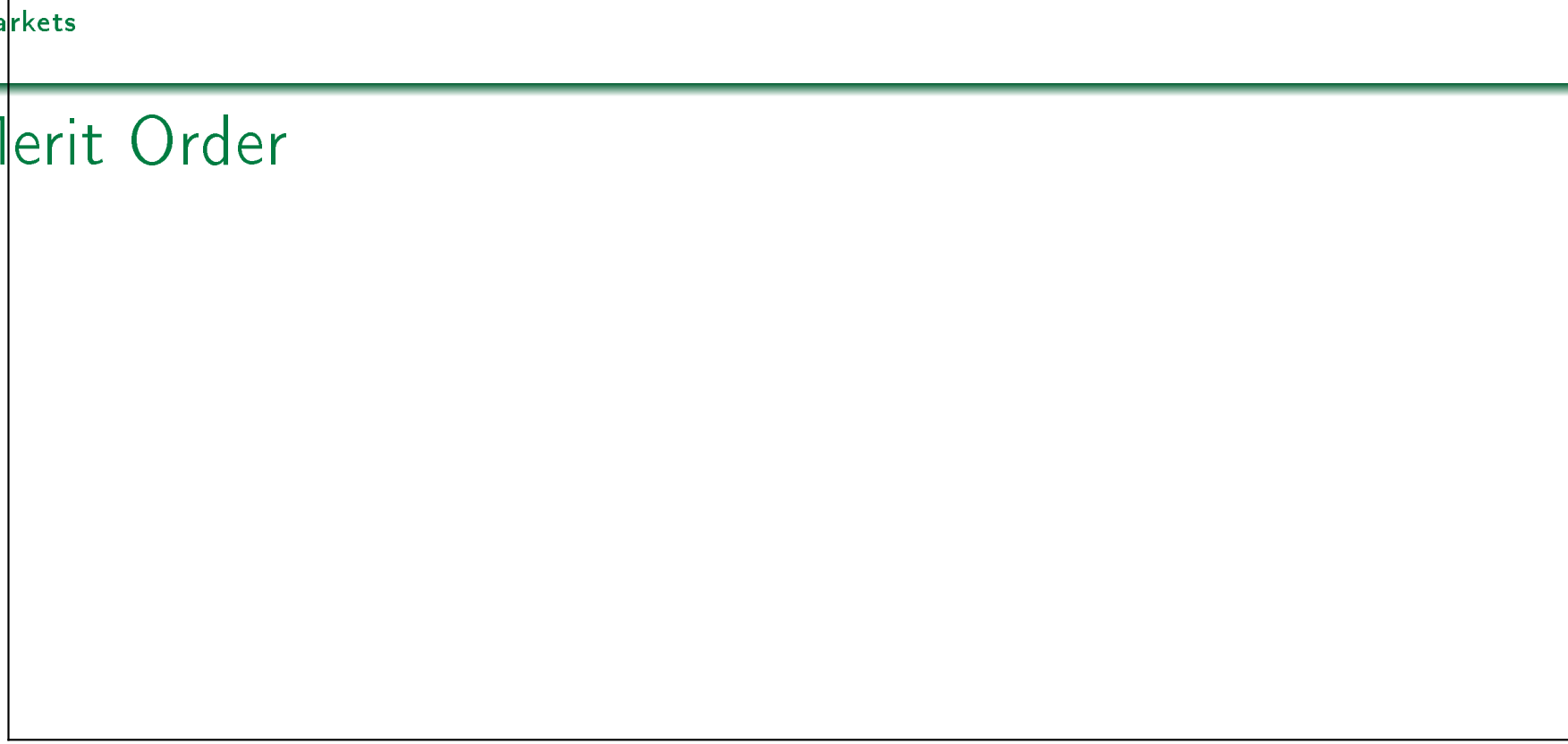
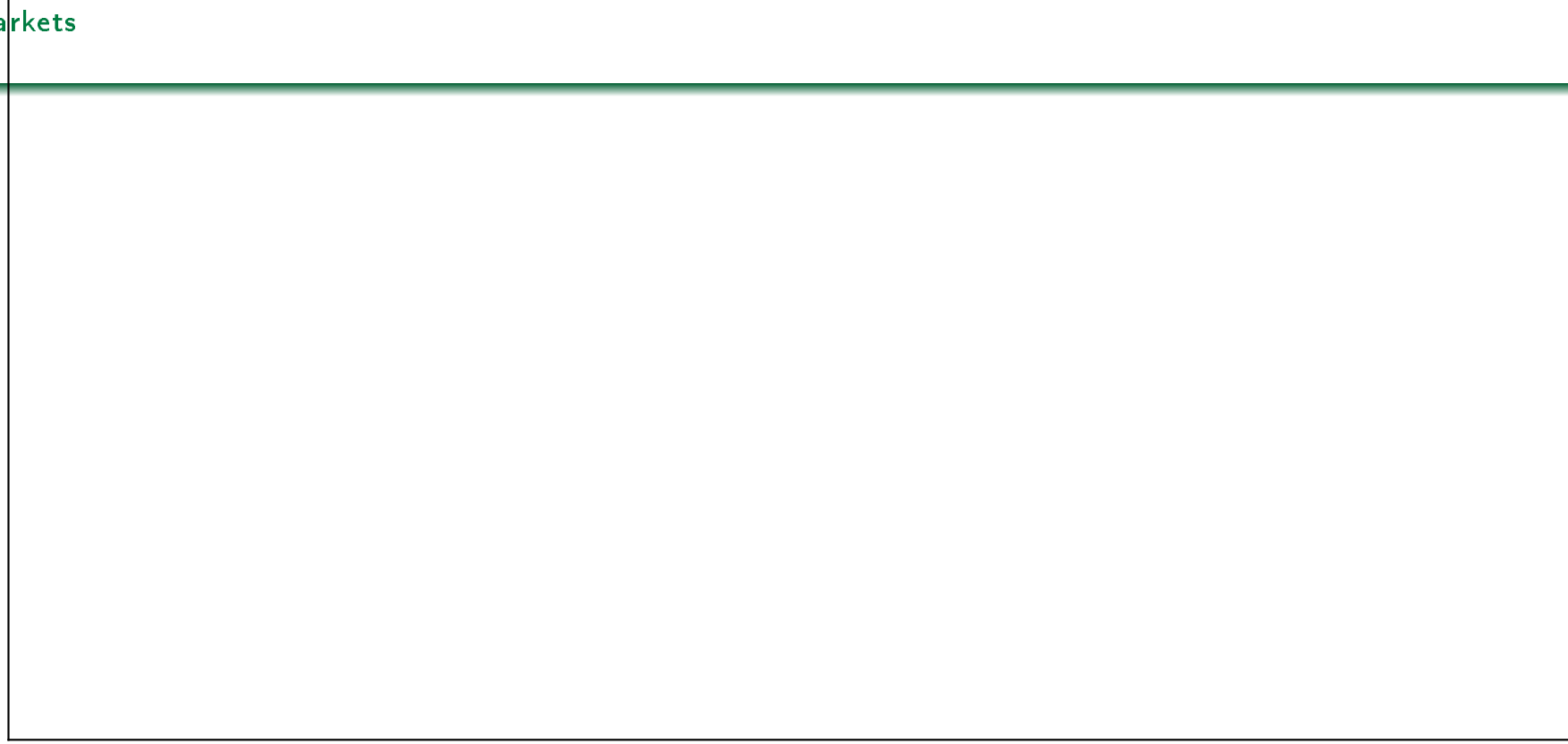


Offers



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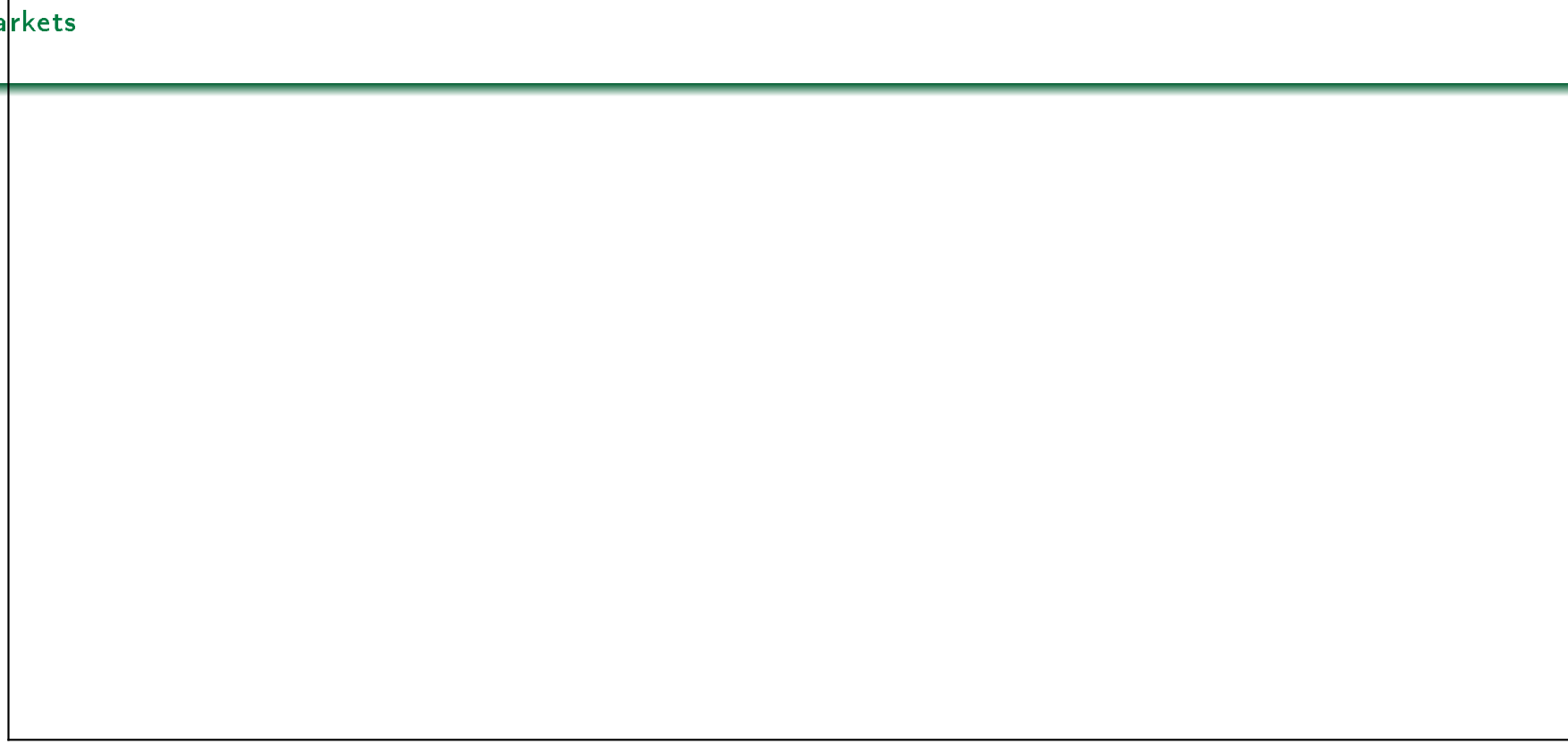
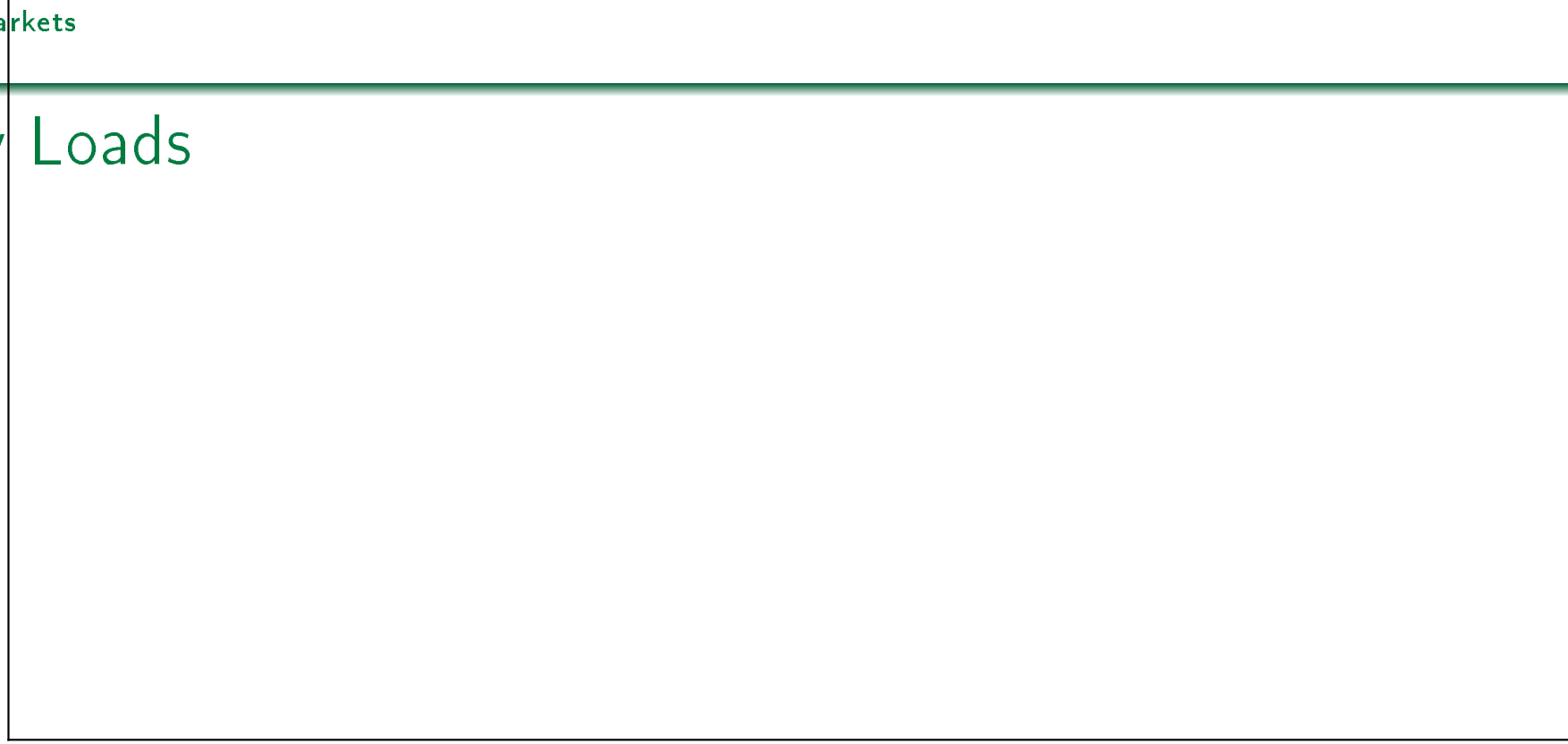
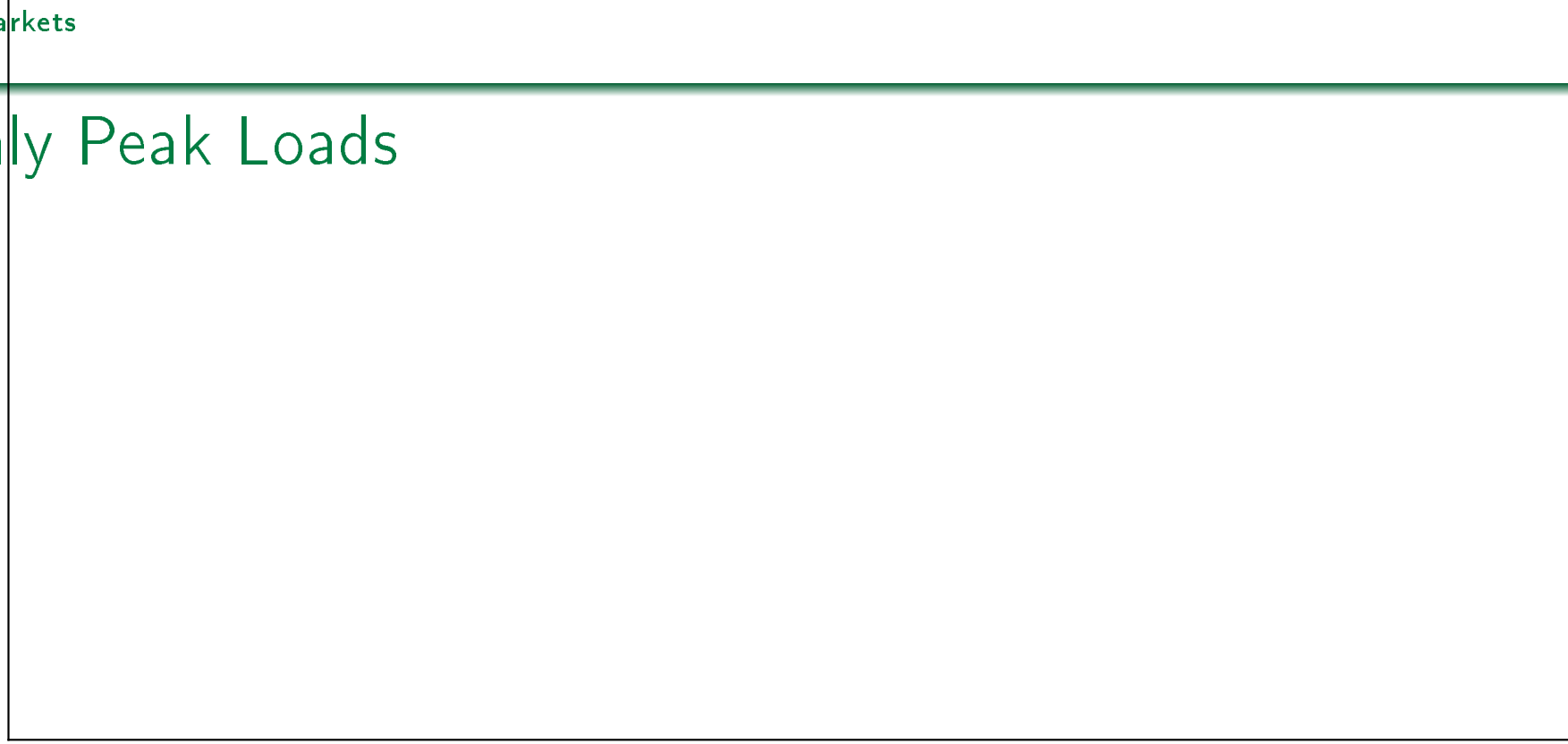


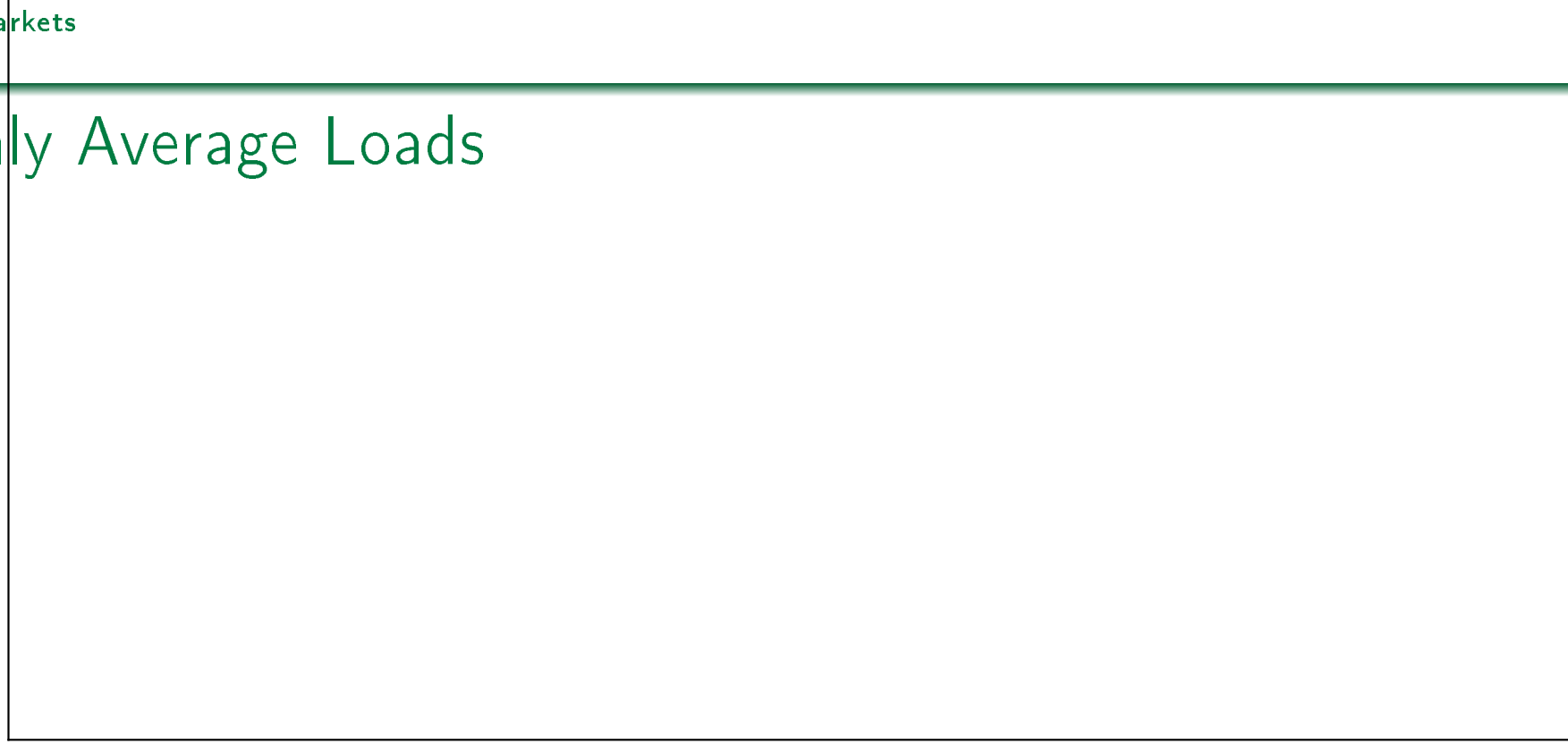
Hourly Loads



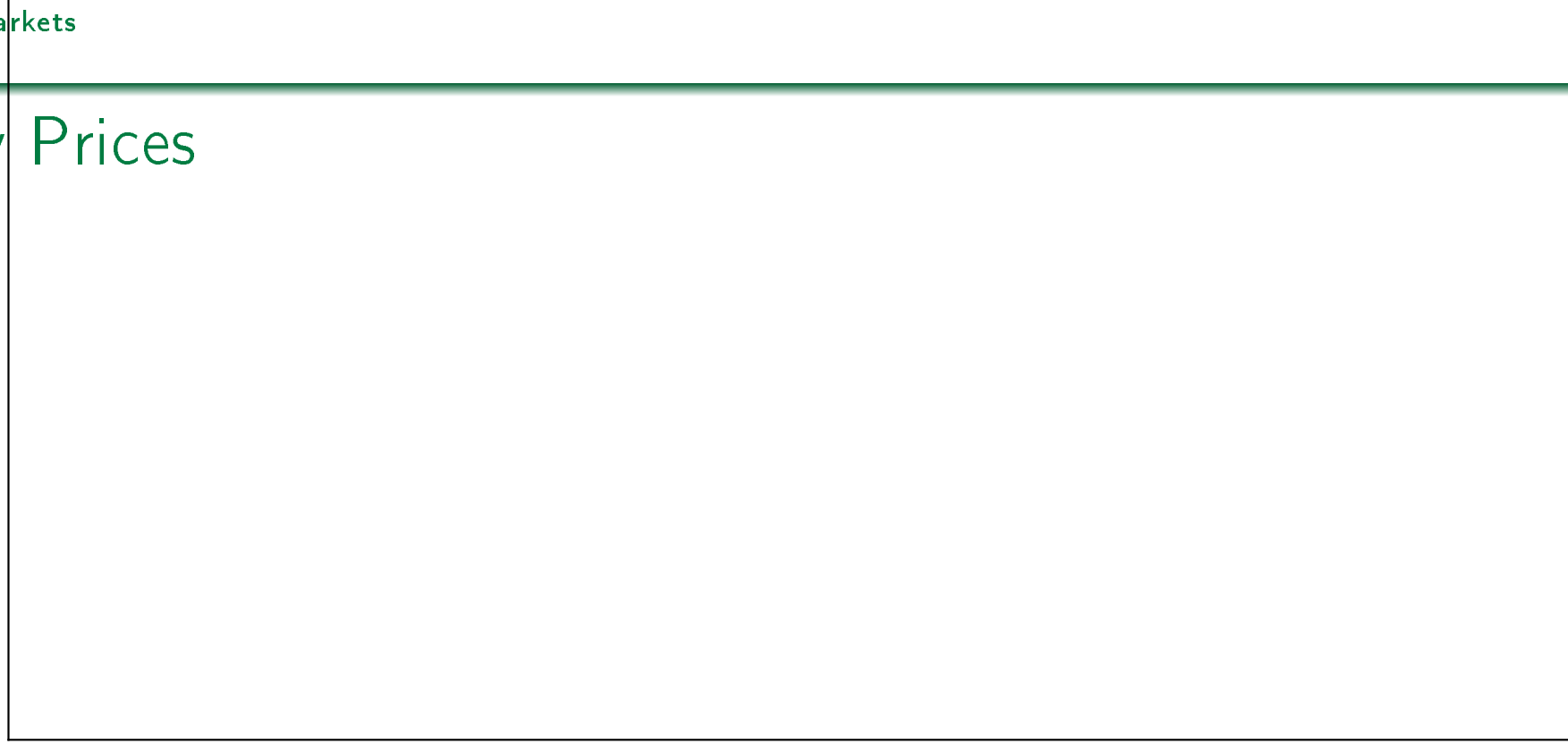
Monthly Peak Loads



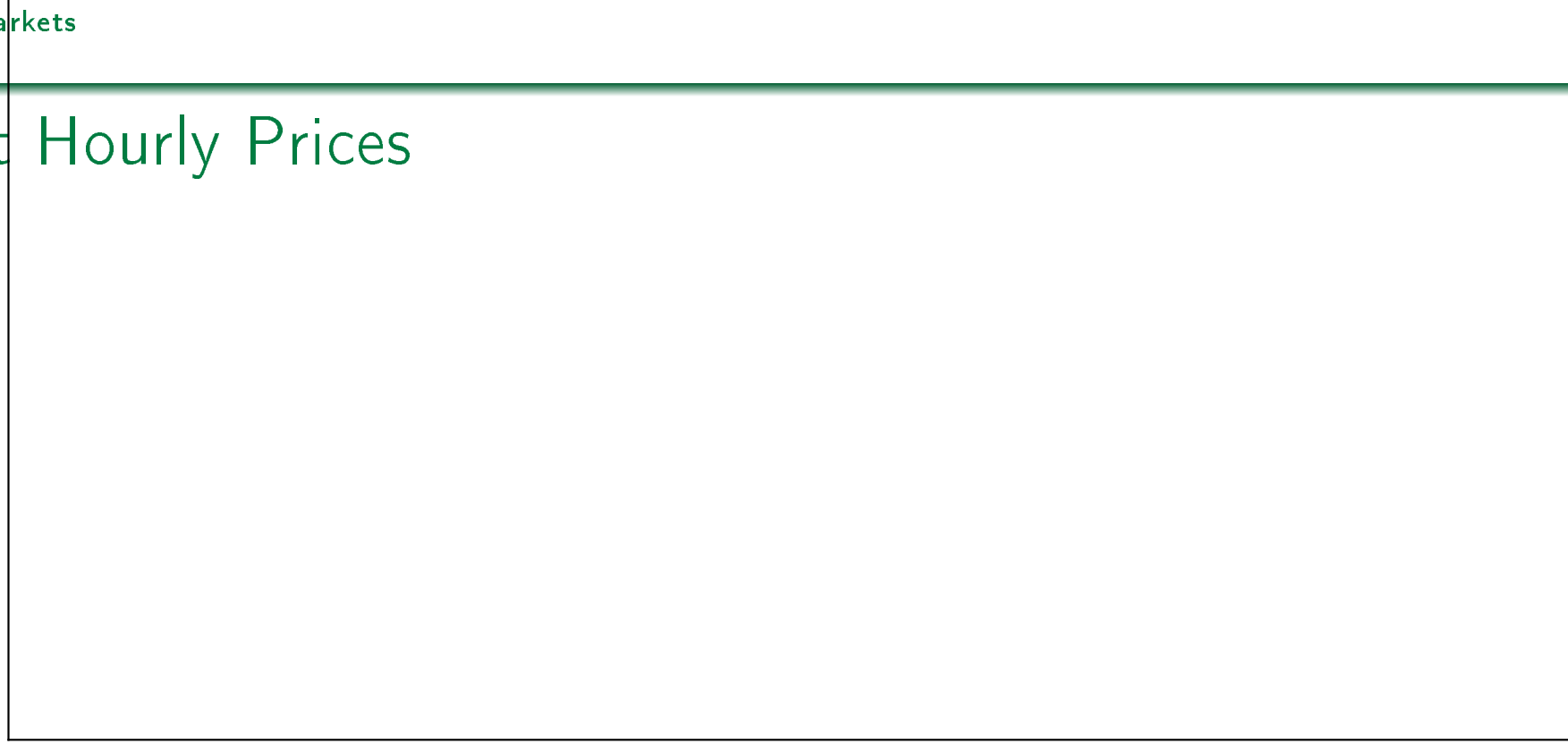
Monthly Average Loads



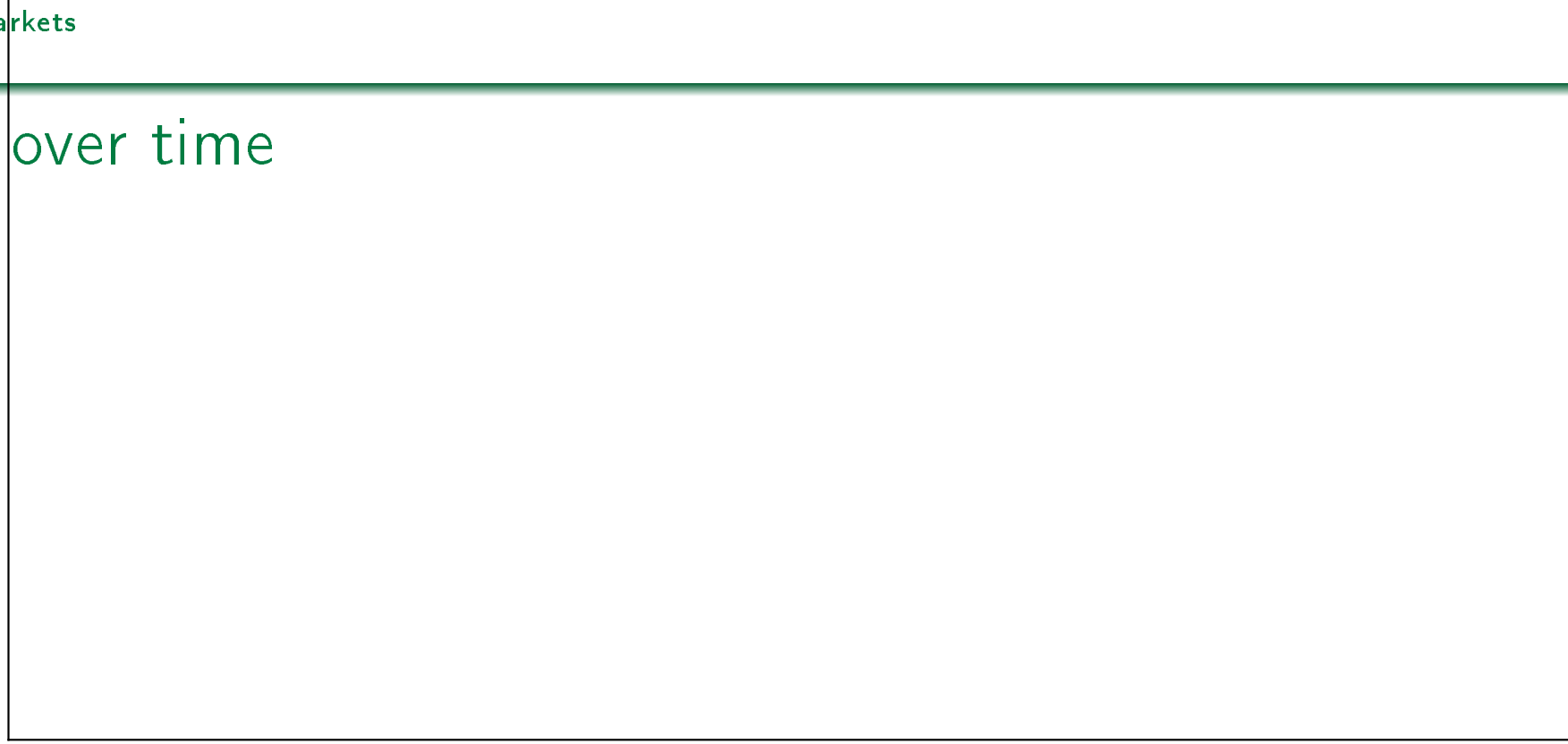
Hourly Prices



Recent Hourly Prices



Prices over time



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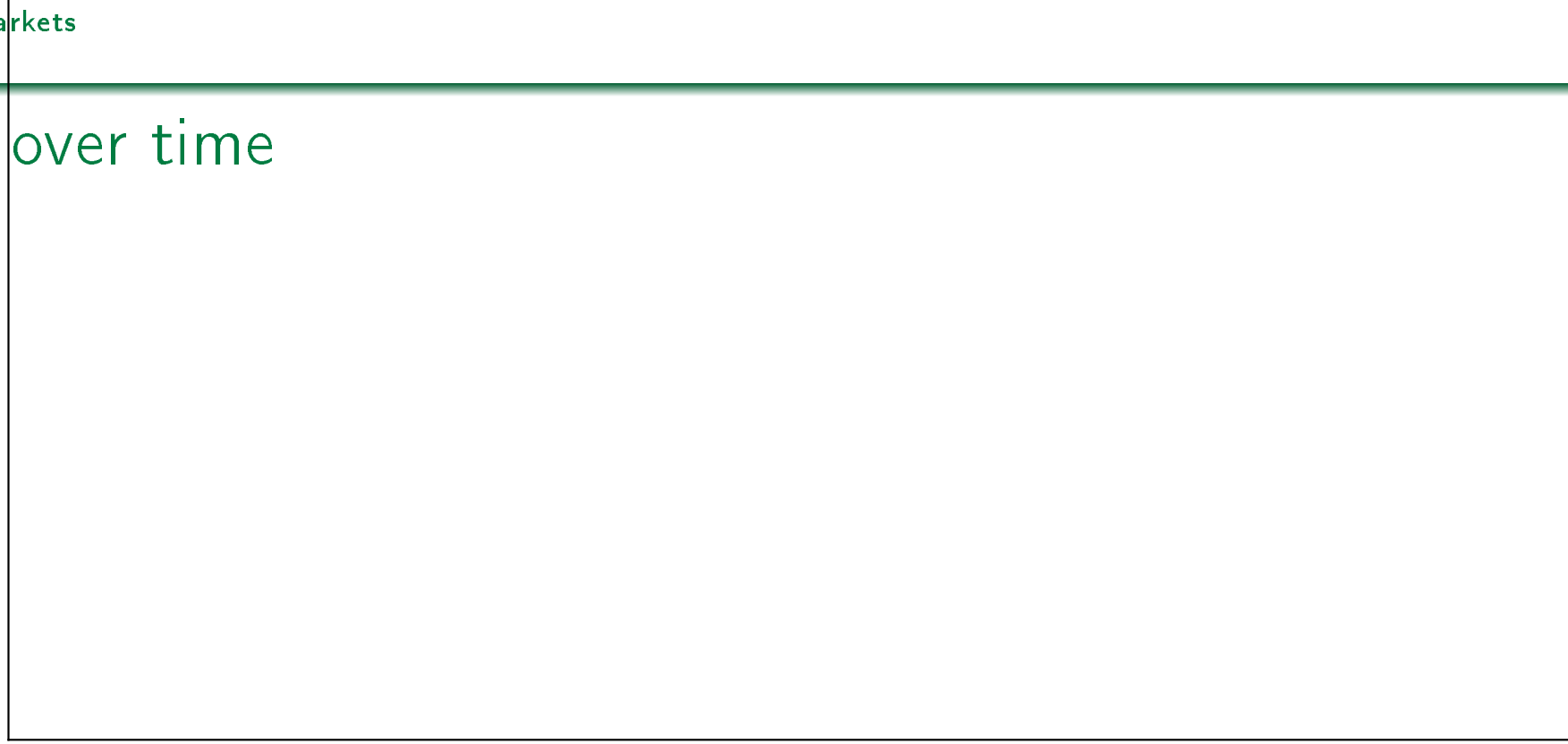

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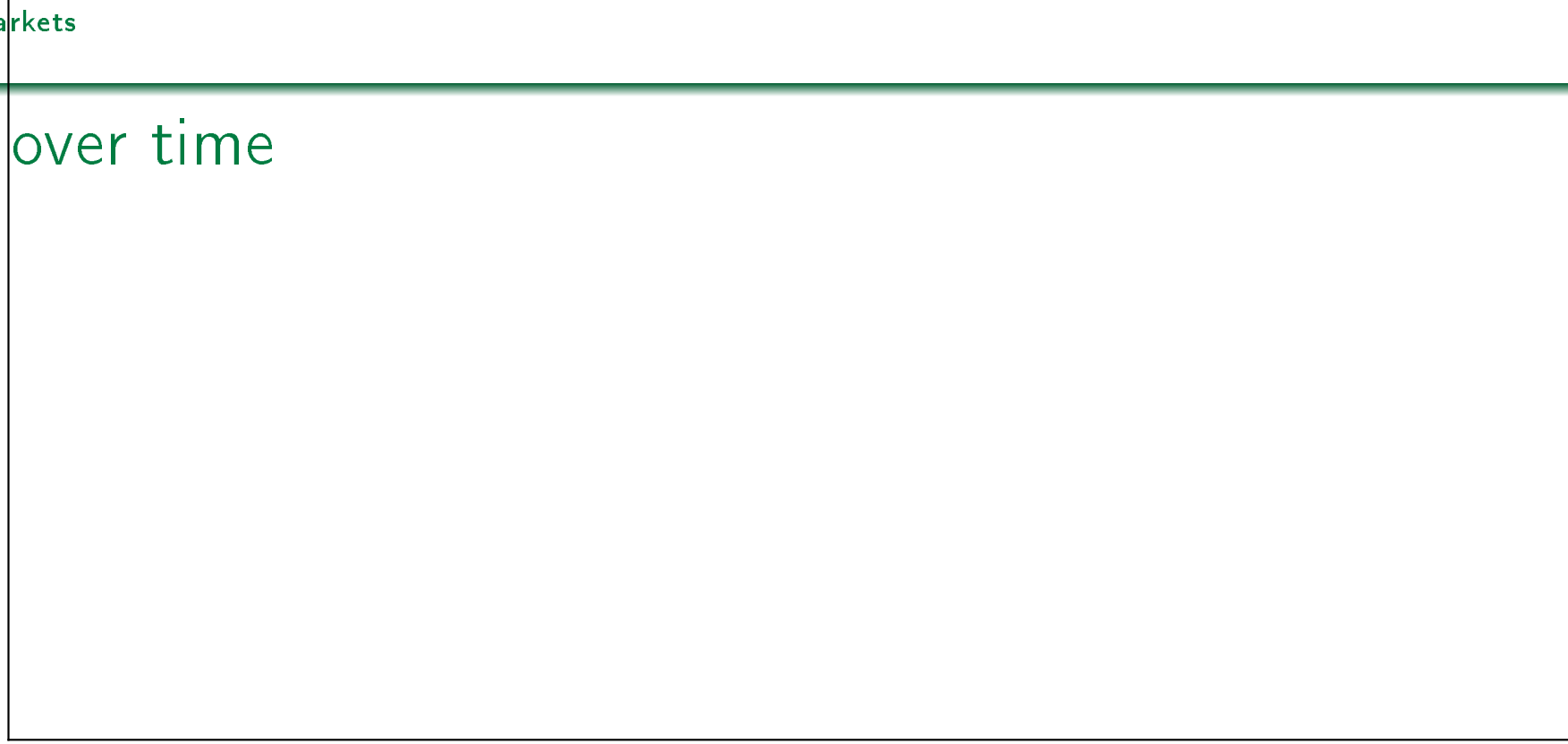
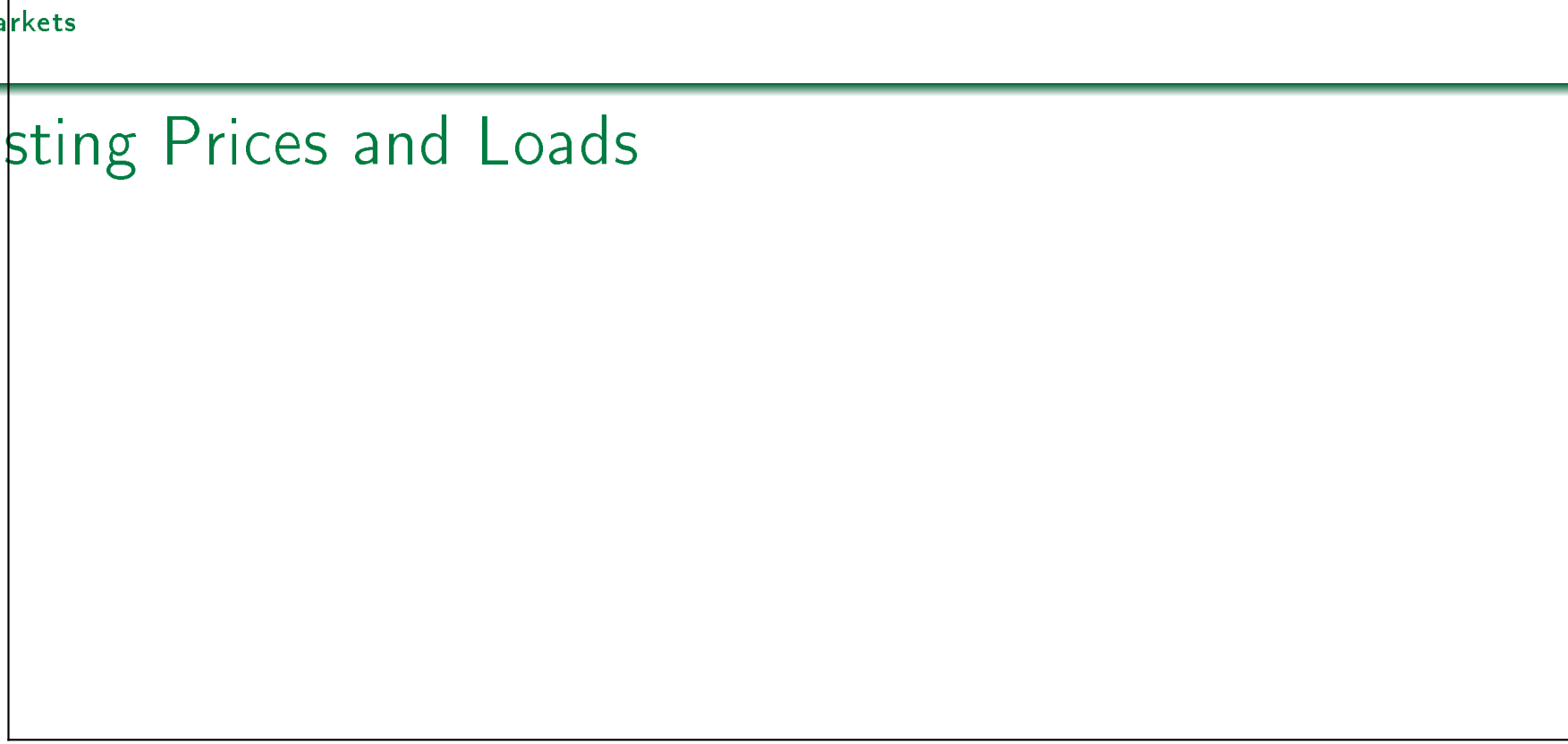
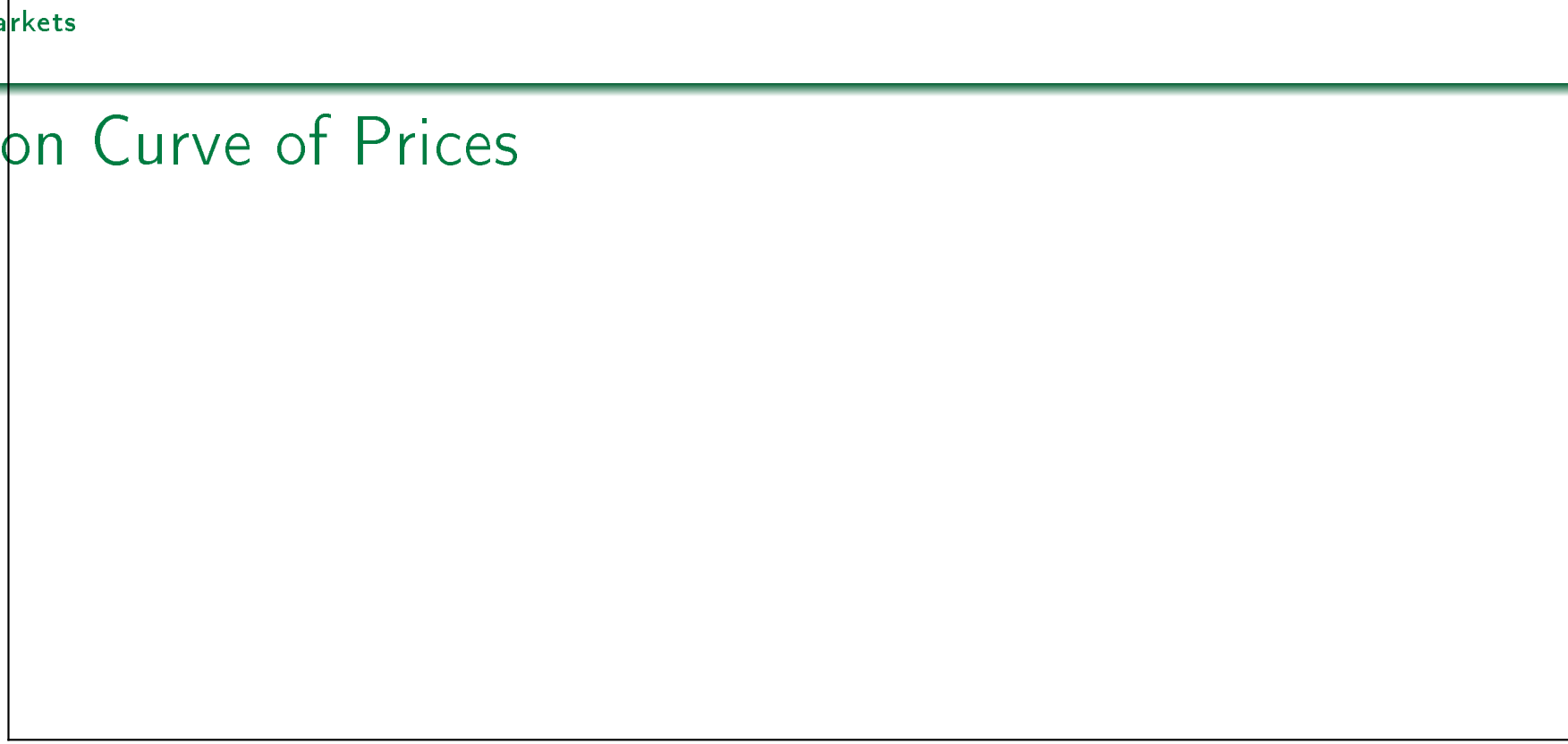


Forecasting Prices and Loads



Duration Curve of Prices



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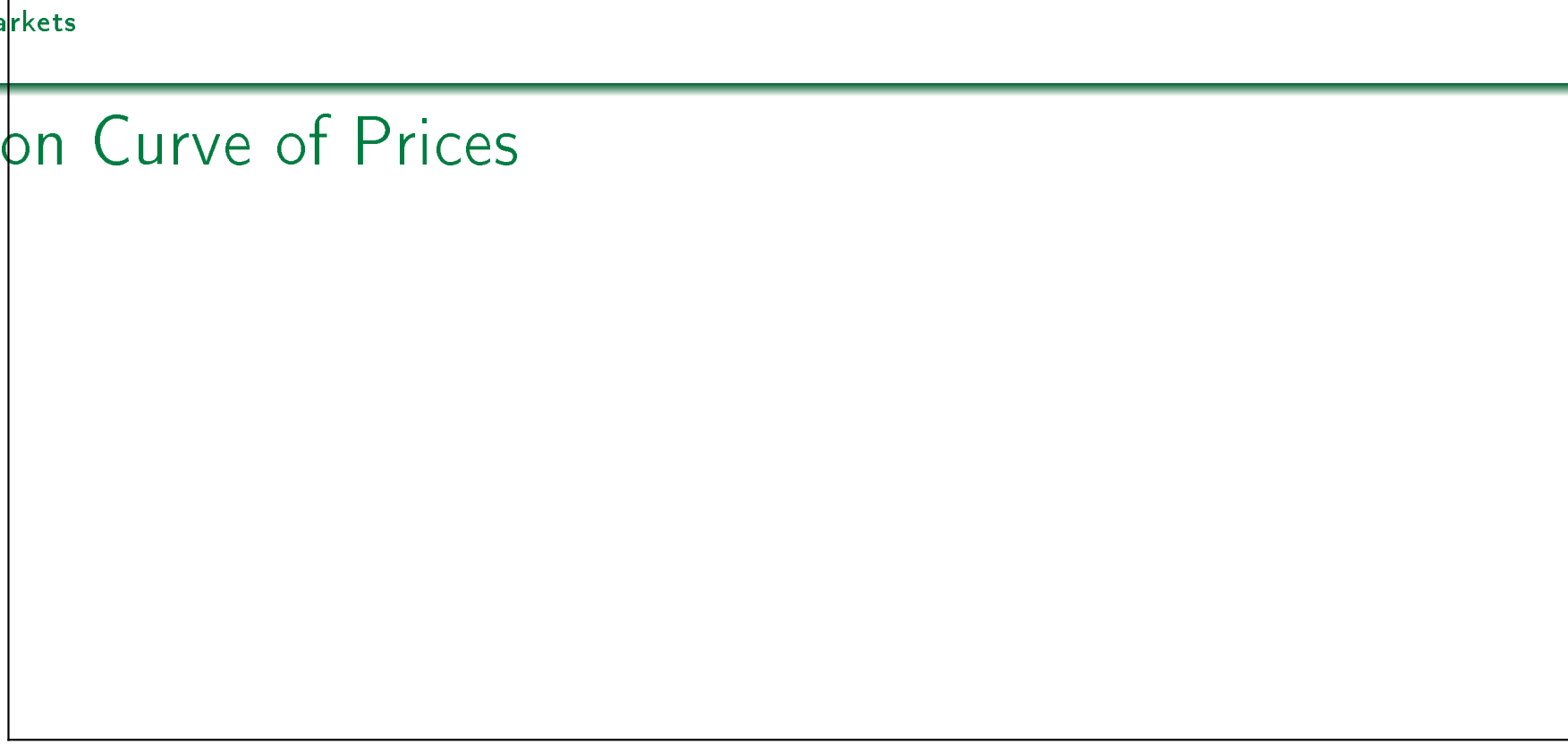
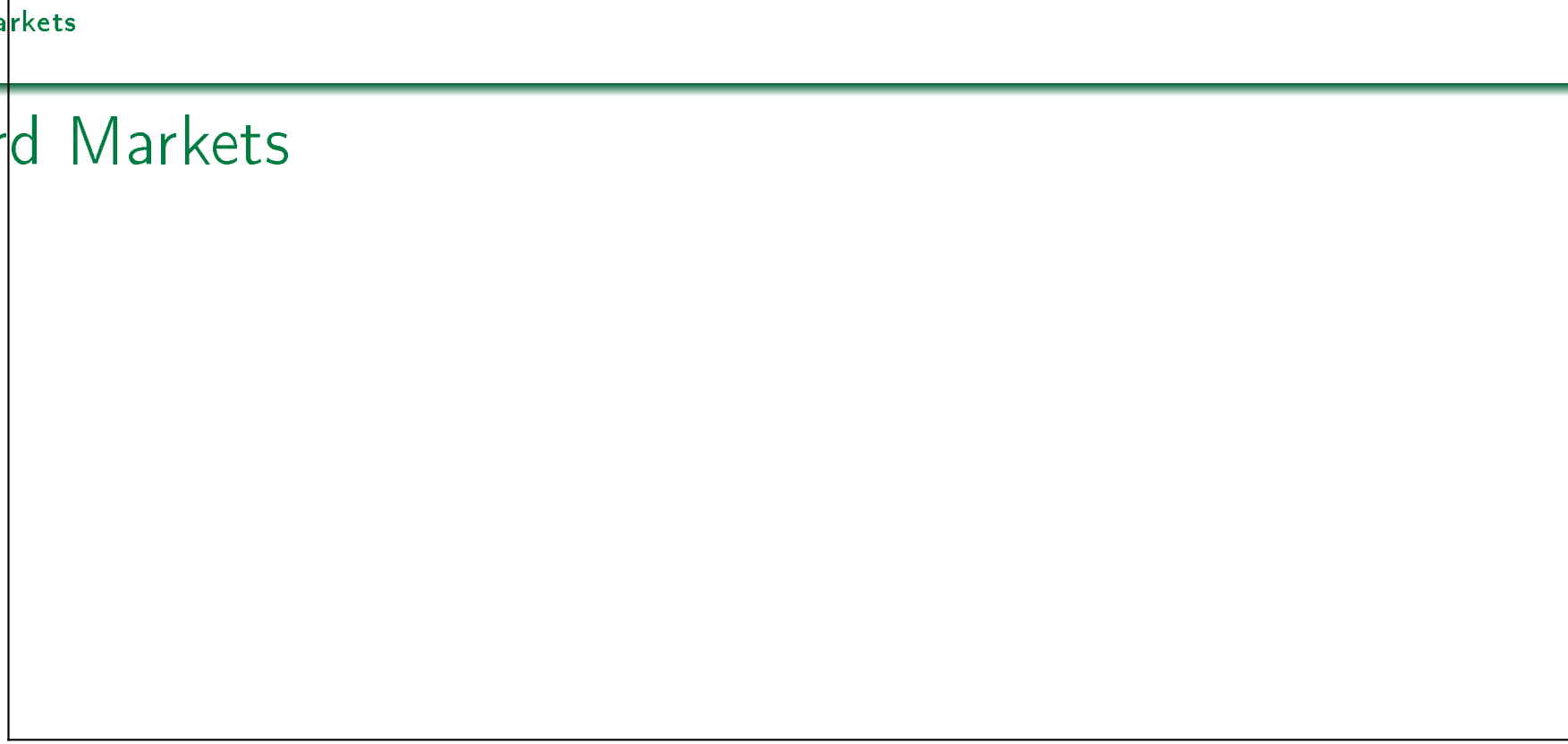


Forward Markets



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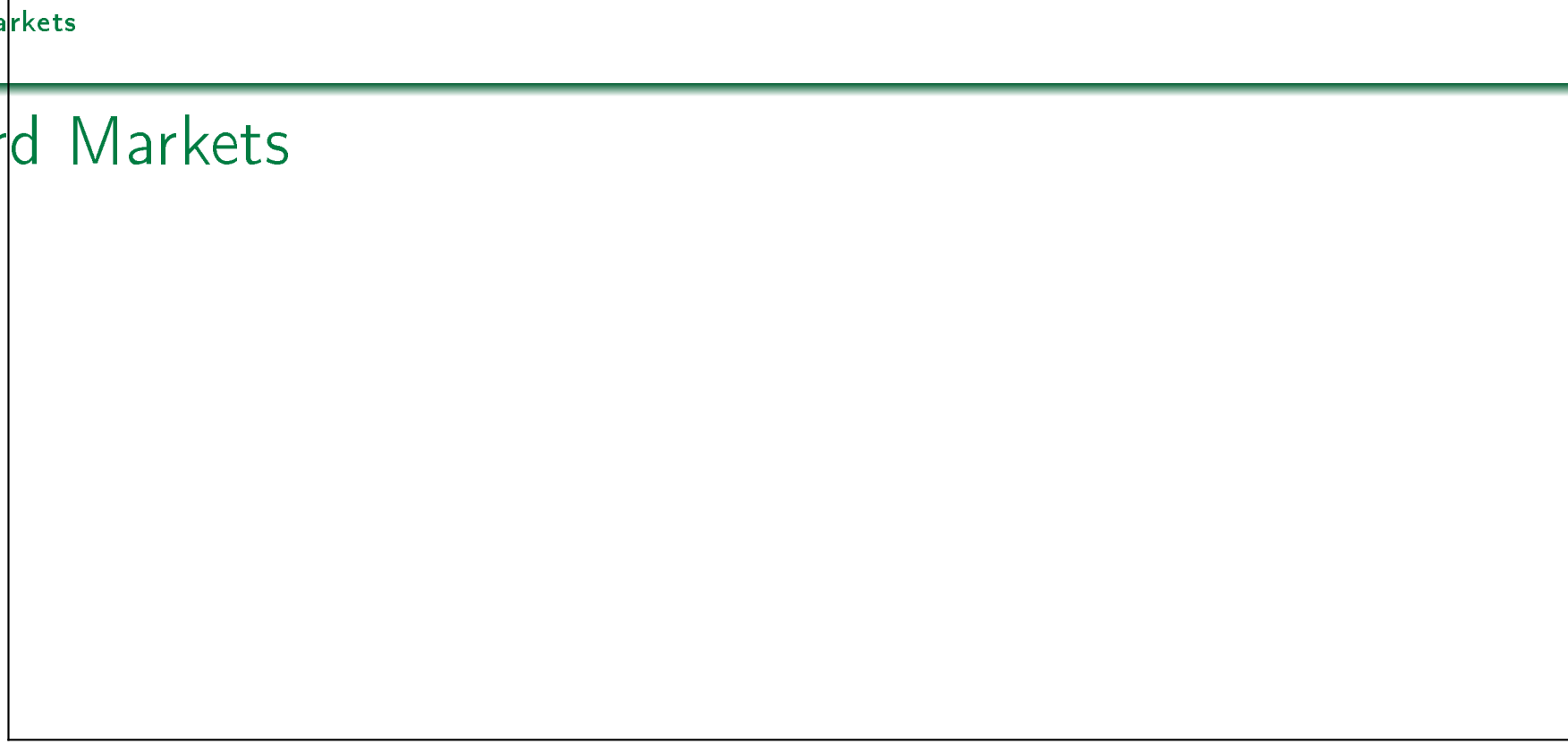

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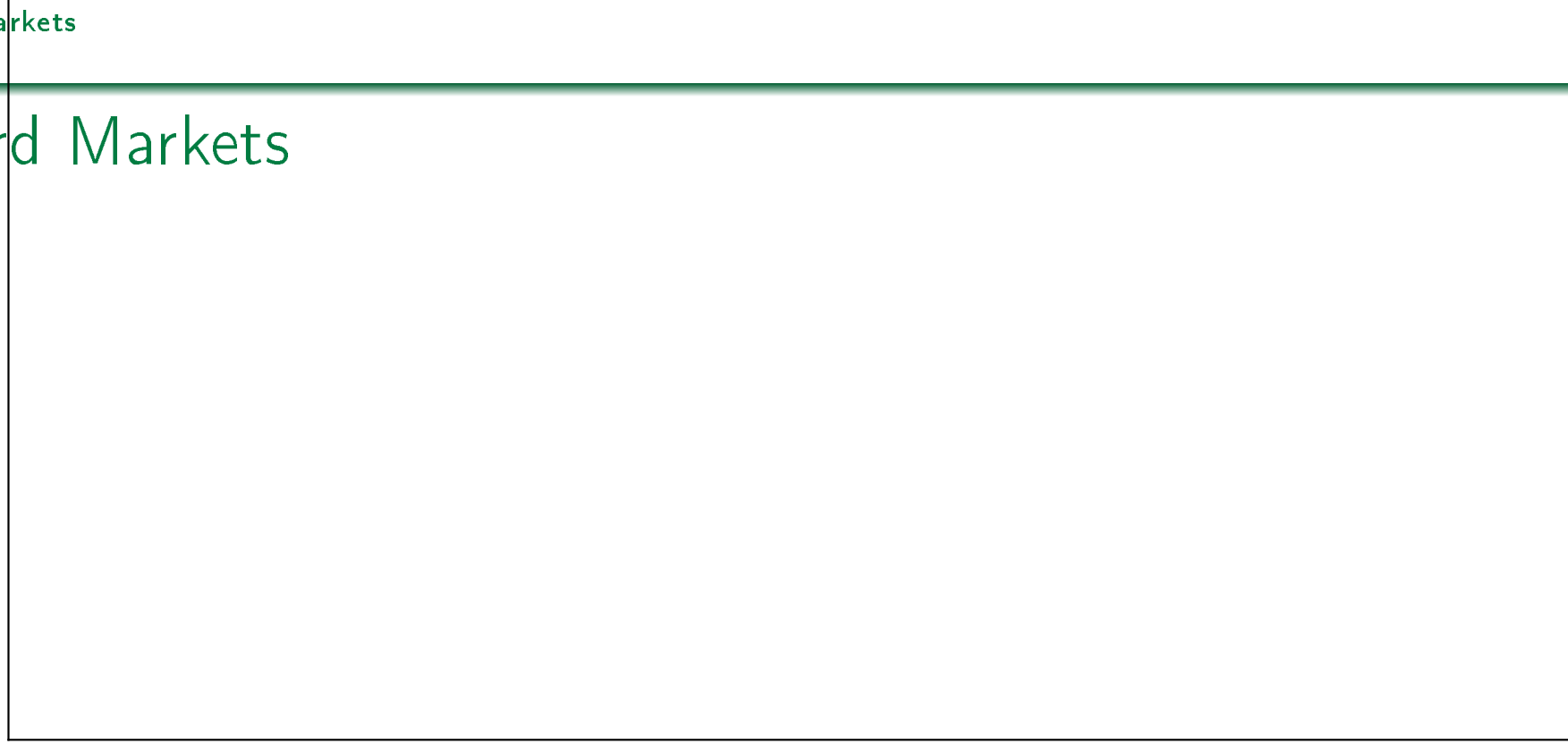

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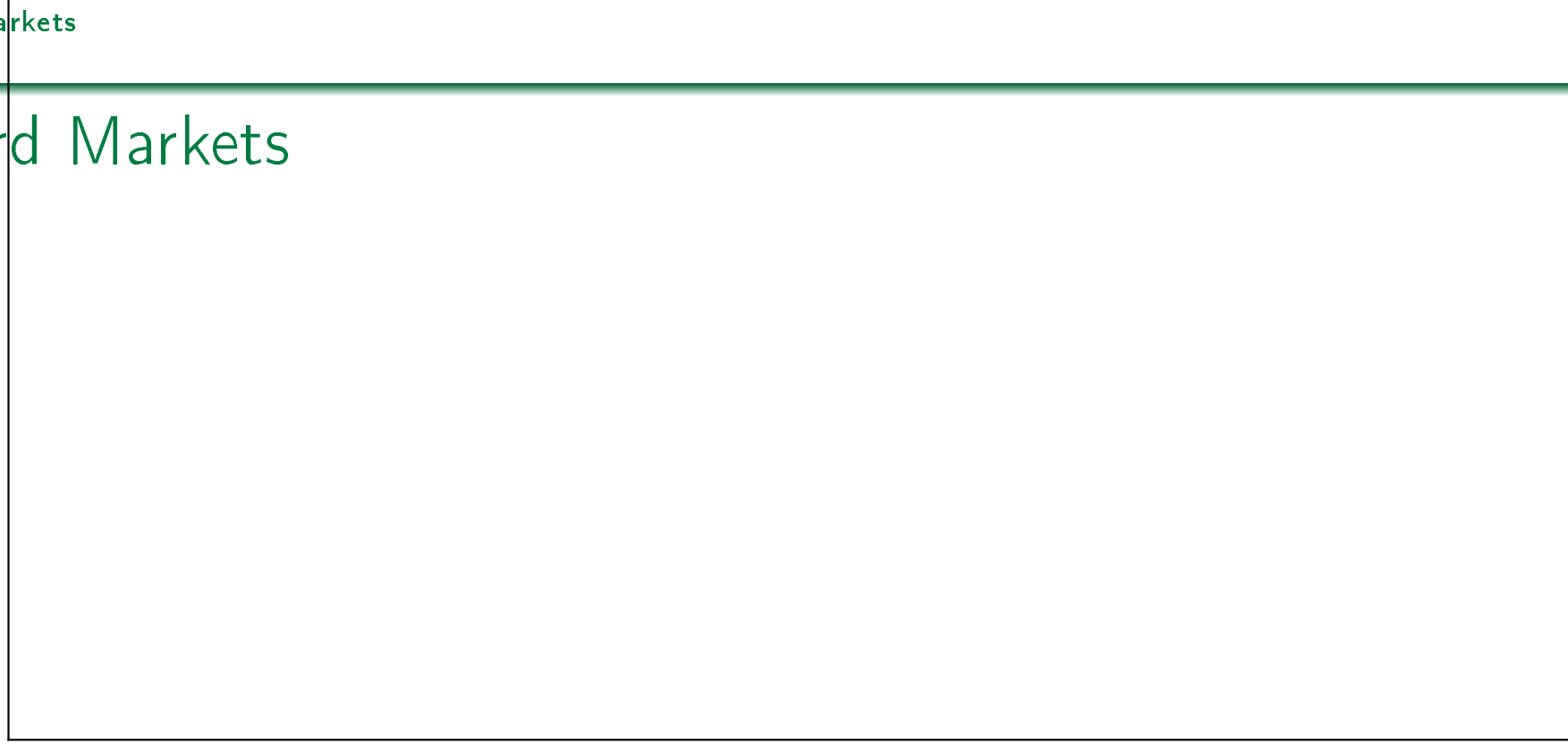

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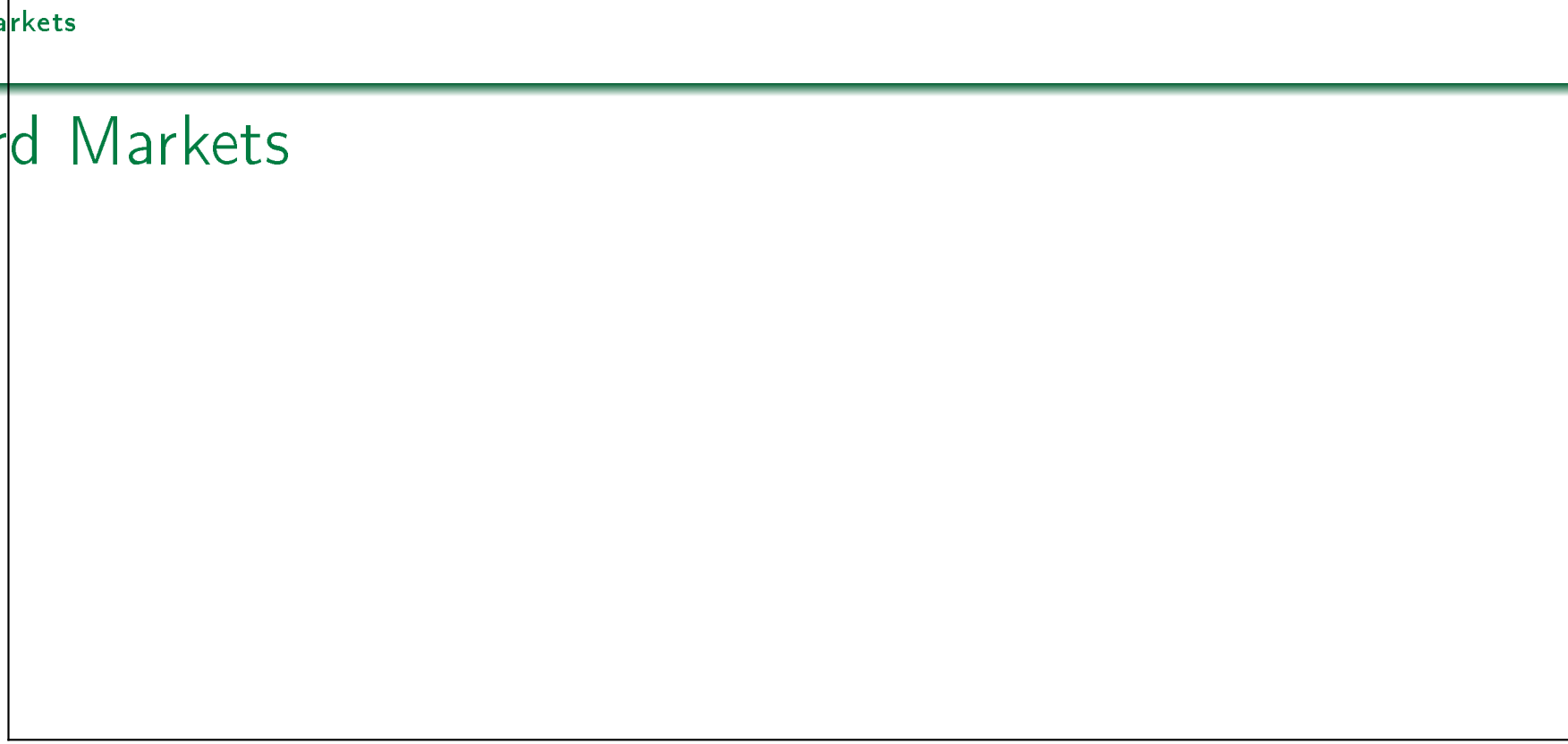

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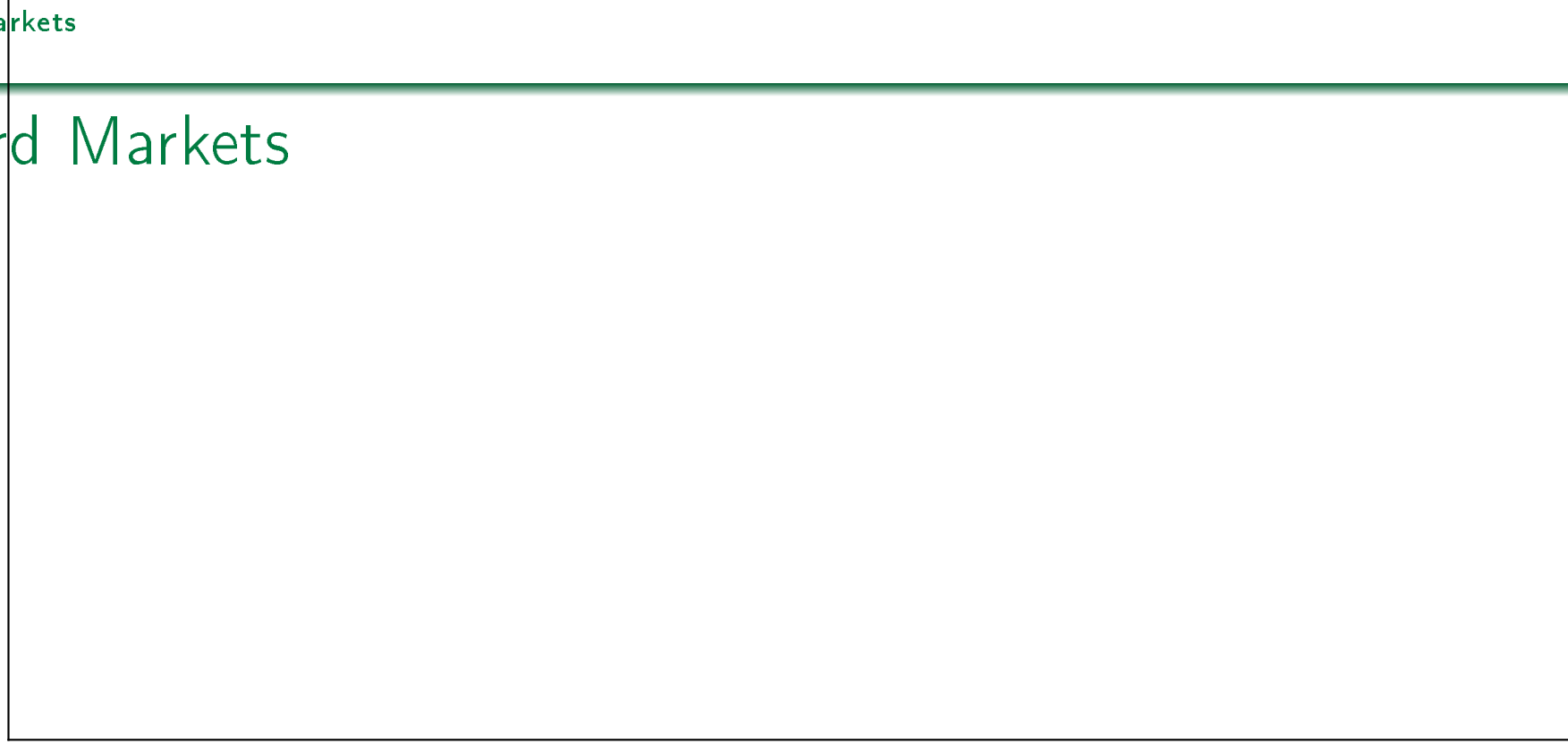
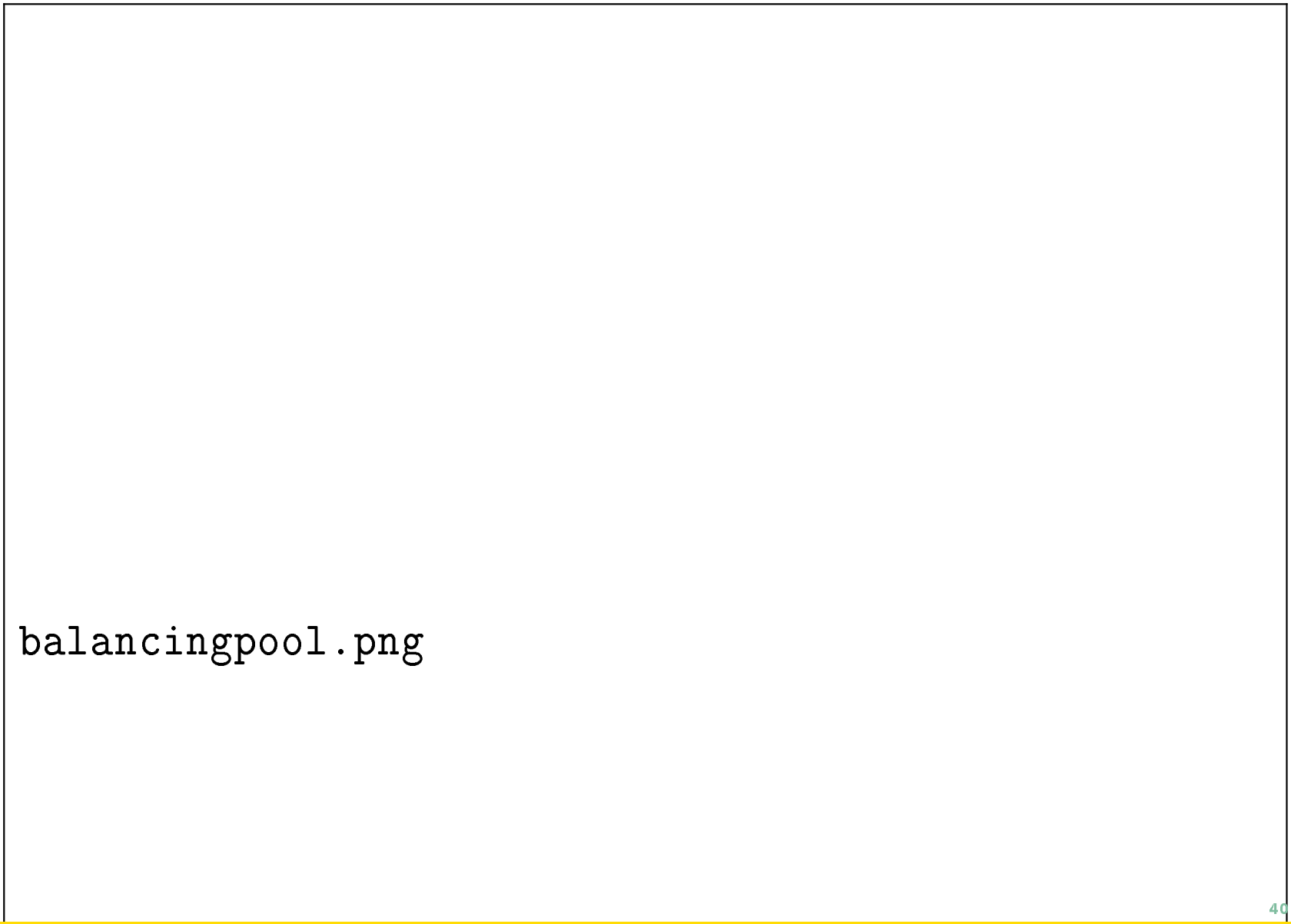


The Balancing Pool: What on earth does it do?



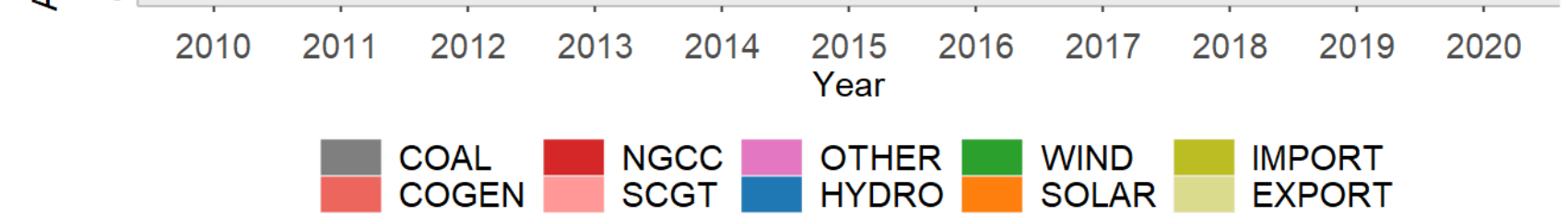
Alberta's Evolving Electricity Market

- Capacity Market
- Coal Phase Out
- Renewables (the REP Program)
- Carbon Pricing

Costs of New Capacity Additions

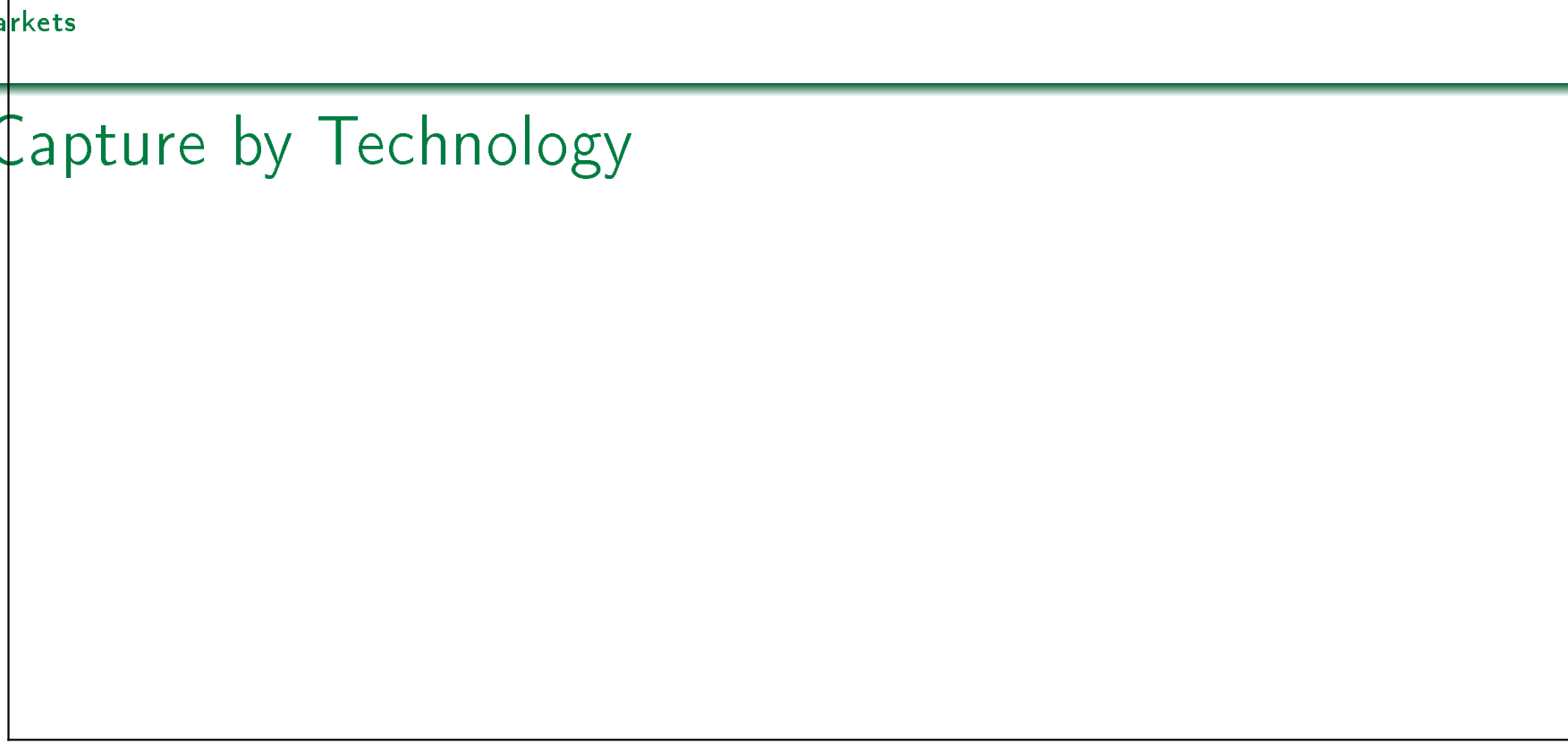
See for more information:
https://www.lazard.com/media/451086/lazards-levelized-cost-of-energy-version-130-vf.pdf

Price (

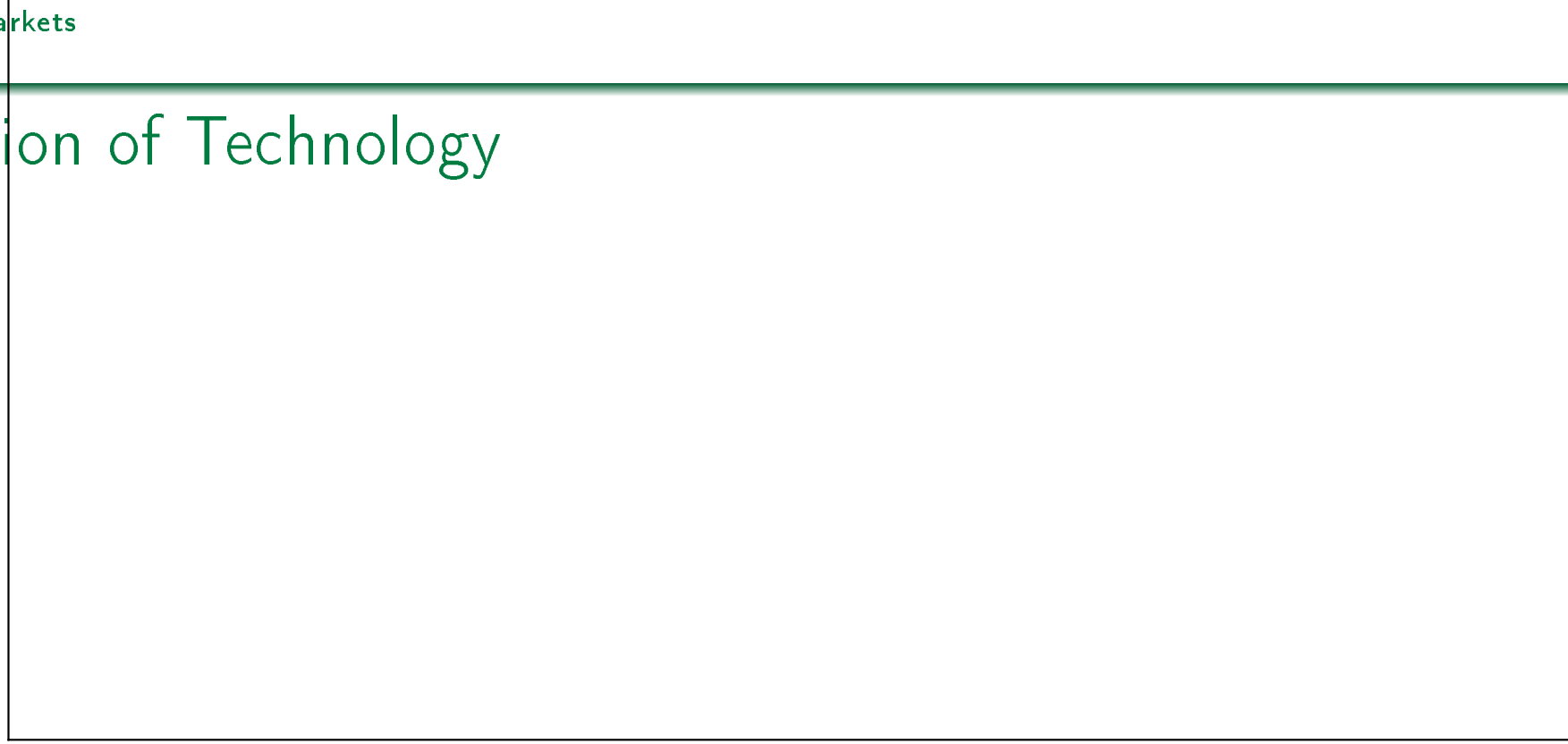


Source: AESO Data, accessed via NRGStream
Graph by @andrew_leach

Price Capture by Technology



Evolution of Technology



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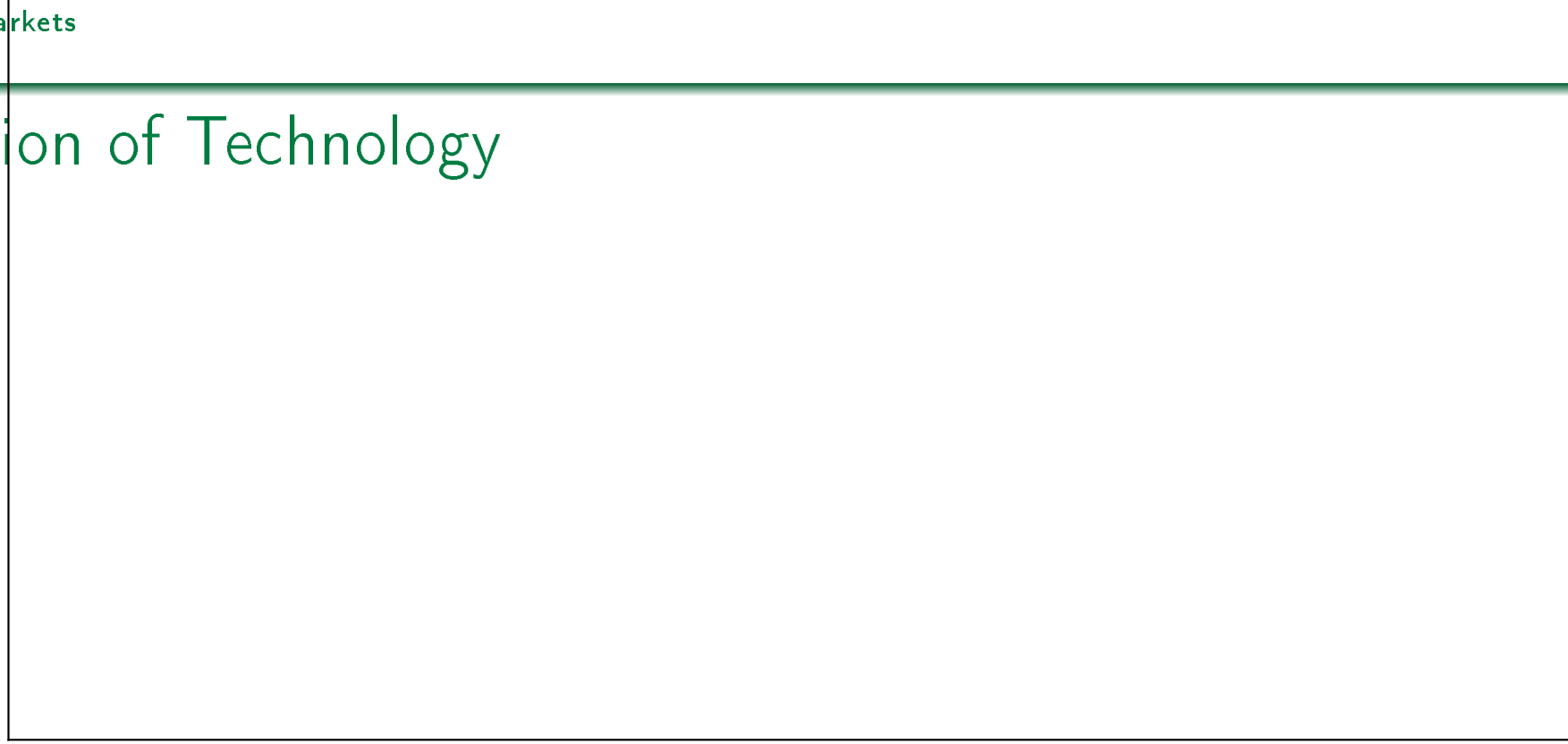
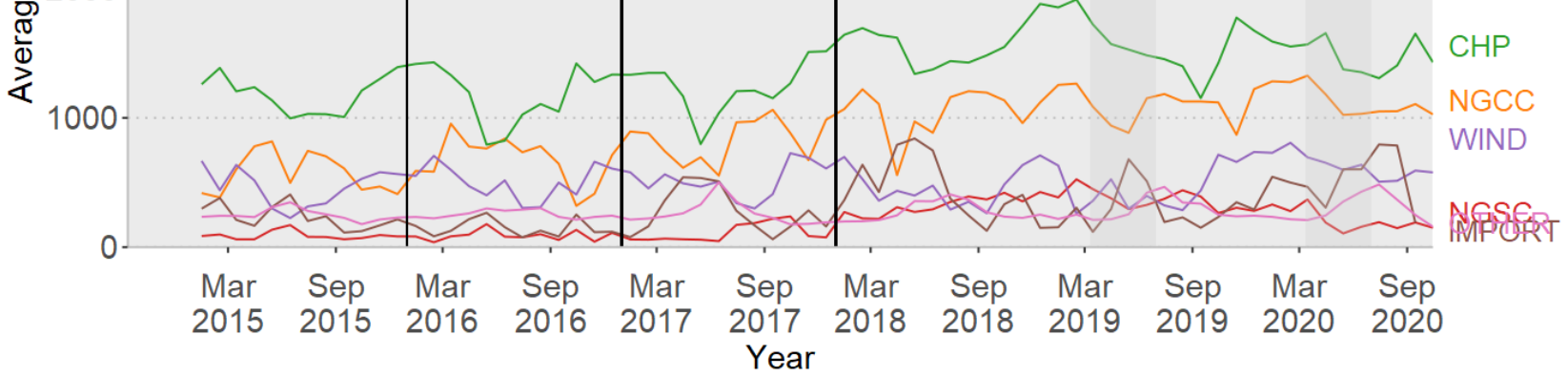


Evolution of Technology

Source: NREL

GHG



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GHG Policy and Electricity Supply

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