A Quantitative Comparison of REDD Reference Level Designs using OSIRIS

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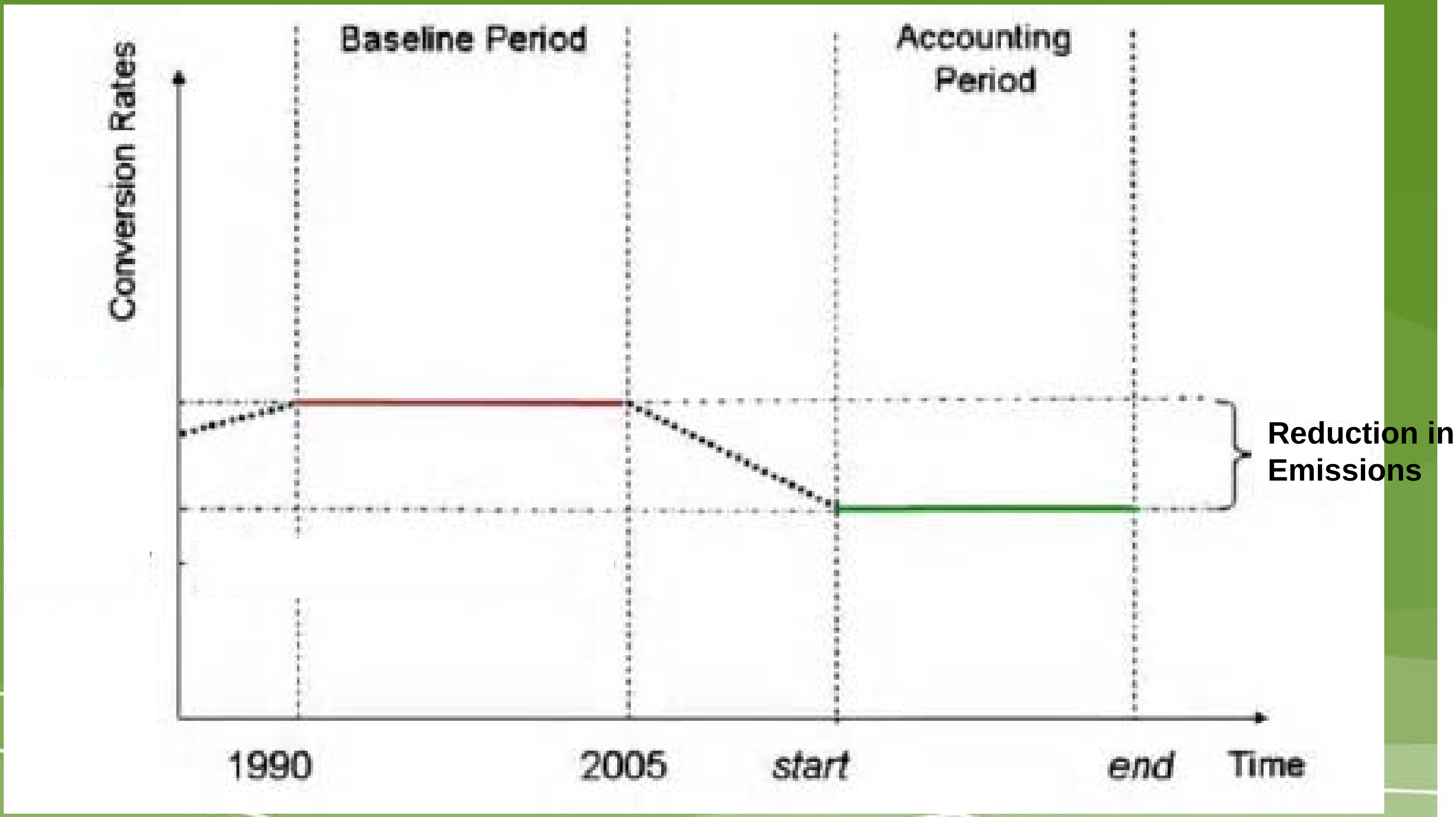
Outline

- The case for REDD+
- REDD+ reference level design options
- The Collaborative Modeling Initiative (CMI) and the OSIRIS model
- Results of reference level design comparison
- Next steps

The case for REDD+

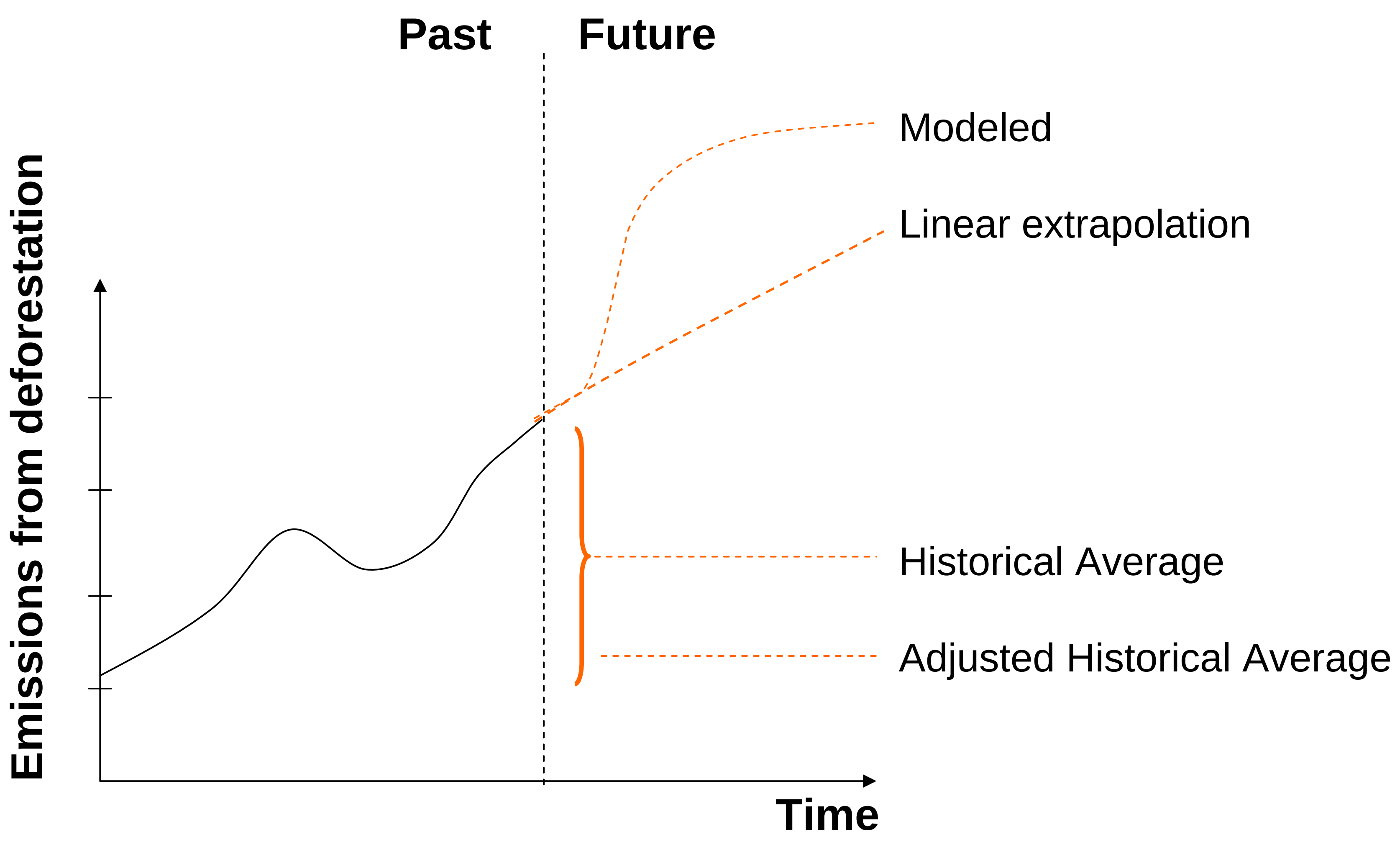
- Deforestation causes ~17% of global GHG emissions (IPCC AR4)
- Can’t meet +2.0 °C target without REDD+ (Eliasch, Warren *et al*, Sawin *et al*)
- Low cost mitigation from REDD+ (Naucler and Enkvist, 2009) means world can meet stronger targets at lower cost with REDD+ than without REDD+
- REDD+ is one “stabilization wedge” (Pacala and Socolow, 2004) which is available now, but won’t be available later

Reference levels determine countries' level of reduction and payment



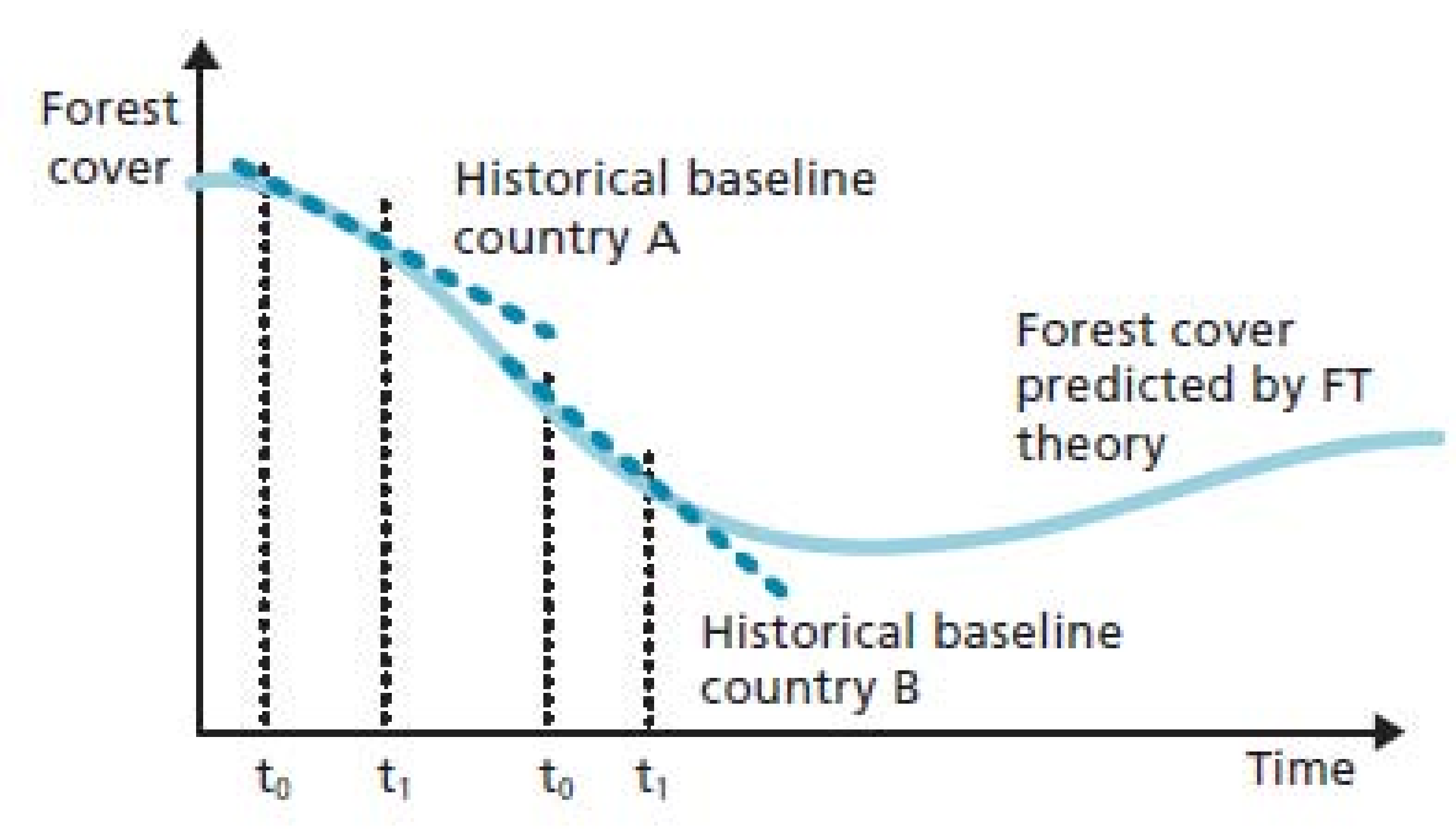
Source: Mollicone *et al*, 2007

How to determine reference level?



Forest Transition Curve

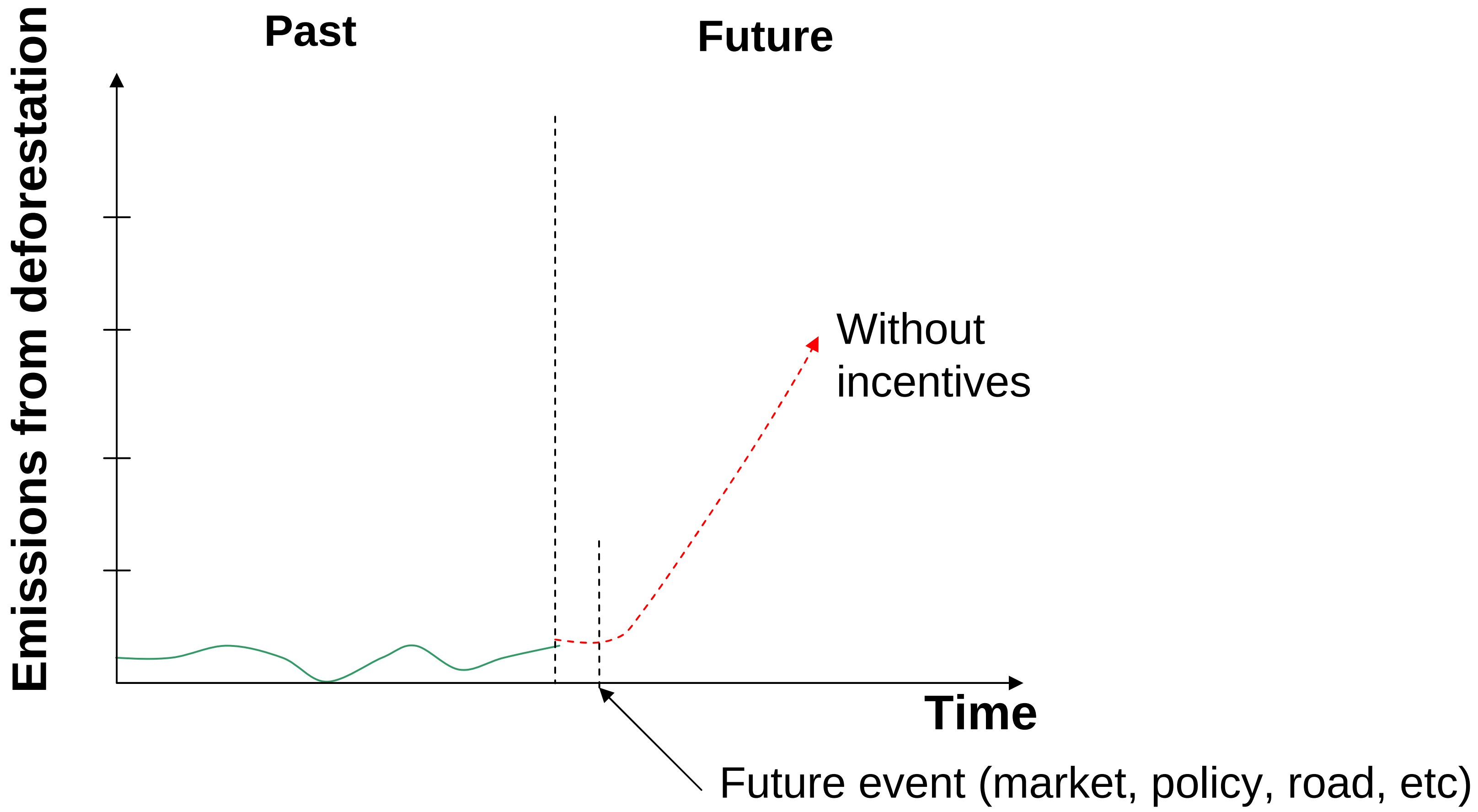
Source: Angelsen et al, 2009



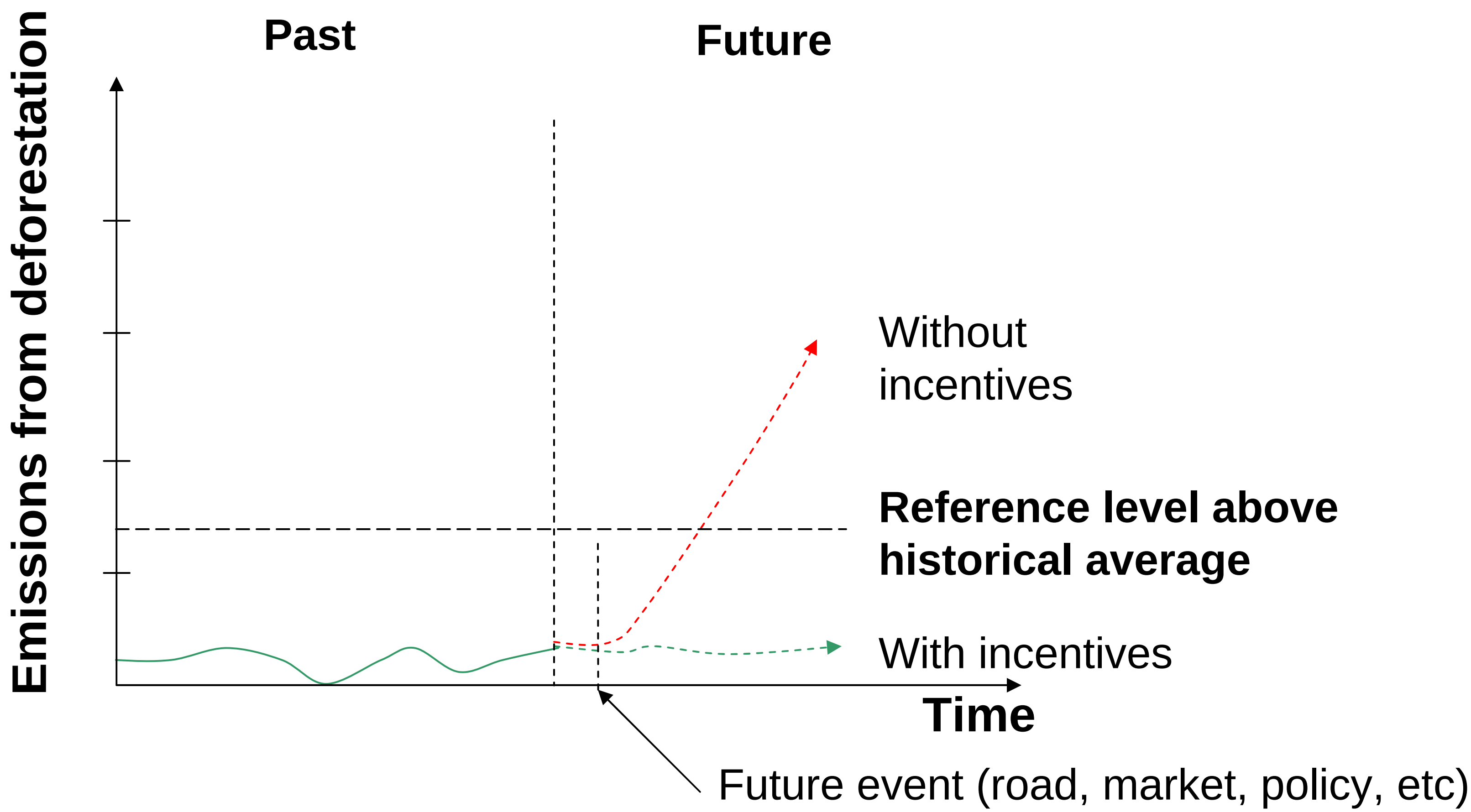
- Historical baselines underpredict BAU in high forest countries (A)
- Historical baselines overpredict BAU in low forest countries (B)

Mather, A.S. (1992). The forest transition. *Area*, 24(4):367-379.

How to avoid emissions from deforestation in countries with historically low deforestation rates?



How to prevent emissions from deforestation in countries with historically low deforestation rates?



Design options compared

Design option	Reference	Description
"Without REDD"	FAO FRA (2005)	Counterfactual business as usual scenario
"National historical"	Santilli *et al* (2005)	Reference rate is historical for all countries
"Higher than historical for countries with low deforestation rates"	Mollicone *et al* (2007); da Fonseca *et al* (2007)	Reference deforestation rate is 0.3% for low-deforestation countries; Baseline is historical for high deforestation countries
"Weighted average of national and global"	Strassburg *et al* (2008)	Reference rate is 0.6*global average rate+ 0.4*historical rate for all countries
"Flow withholding and stock payment"	Cattaneo *et al* (2008)	Reference rate is historical for all countries; 30% "withholding" on flow payments to pay for stock payments
"Uniform fraction of at-risk stock"	Ashton *et al* (2008)	Reference level is 1% of at-risk forest for all countries; 80% of total forest is assumed to be at-risk in all countries
"Cap and trade for REDD"	Eliasch (2008); For comparison only	Cap is historical for all countries; countries above cap must purchase credits

Collaborative Modeling Initiative on REDD Economics:

- Convene REDD economists from five institutions to supply quantitative economic analysis in support of UNFCCC negotiations on REDD+

- Compare magnitude and distribution of impacts across REDD mechanism design options using standardized data and assumptions:
  - Phase I: National-level, short-term analysis (in review)
  - “Options Assessment Report” on REDD to Government of Norway (March, 2009)
  - Phase II: Analysis to 2050 (in development with IIASA)
  - Phase III: Downscaled analyses for key countries (July, 2009)

Open Source Impacts of REDD Incentives Spreadsheet (OSIRIS)

- OSIRIS is a free, transparent, accessible and open source decision support spreadsheet tool designed to support UNFCCC negotiations on REDD+.

- OSIRIS country-by-country outputs:
  - Emissions reductions (ton CO_2e/yr)
  - Avoided deforestation (Ha/yr)
  - Distribution of revenue ($/yr)
  - Cost-efficiency of emissions reductions ($/ton CO_2e)

http://www.conservation.org/osiris

OSIRIS flexible inputs

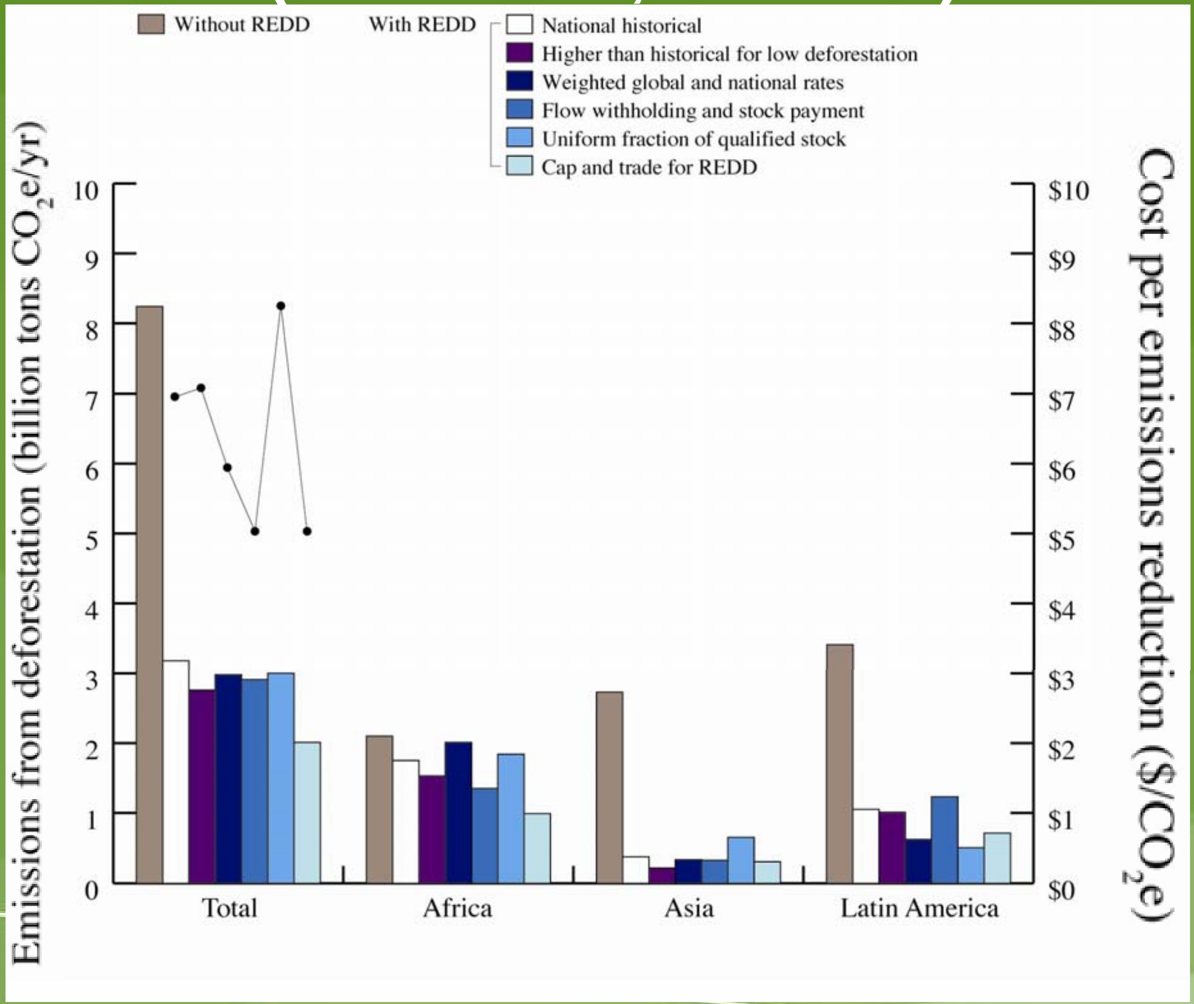
- Carbon price (\$/ton CO_2)
- Management cost and transaction cost (\$/Ha or \$/ton CO_2)
- Fraction of soil carbon eligible for REDD+
- Market, fund, or quota
- Timing of payment
- Suite of countries participating in REDD+
- Baseline period ('90-'00 or '00-'05)
- Responsiveness of price of frontier land agricultural output to changes in extent of deforestation ("price elasticity of demand")
- Weight of countries' preference for REDD+ surplus vs. agricultural surplus
- Design-specific parameters

The OSIRIS Model

- Agriculture and timber compete with forests for use of tropical frontier land
- Incorporates commodities prices, leakage, and design-specific incentives to reduce or increase emissions from deforestation
- Uses best available global data on forest cover, forest loss, carbon density, agricultural returns, timber returns

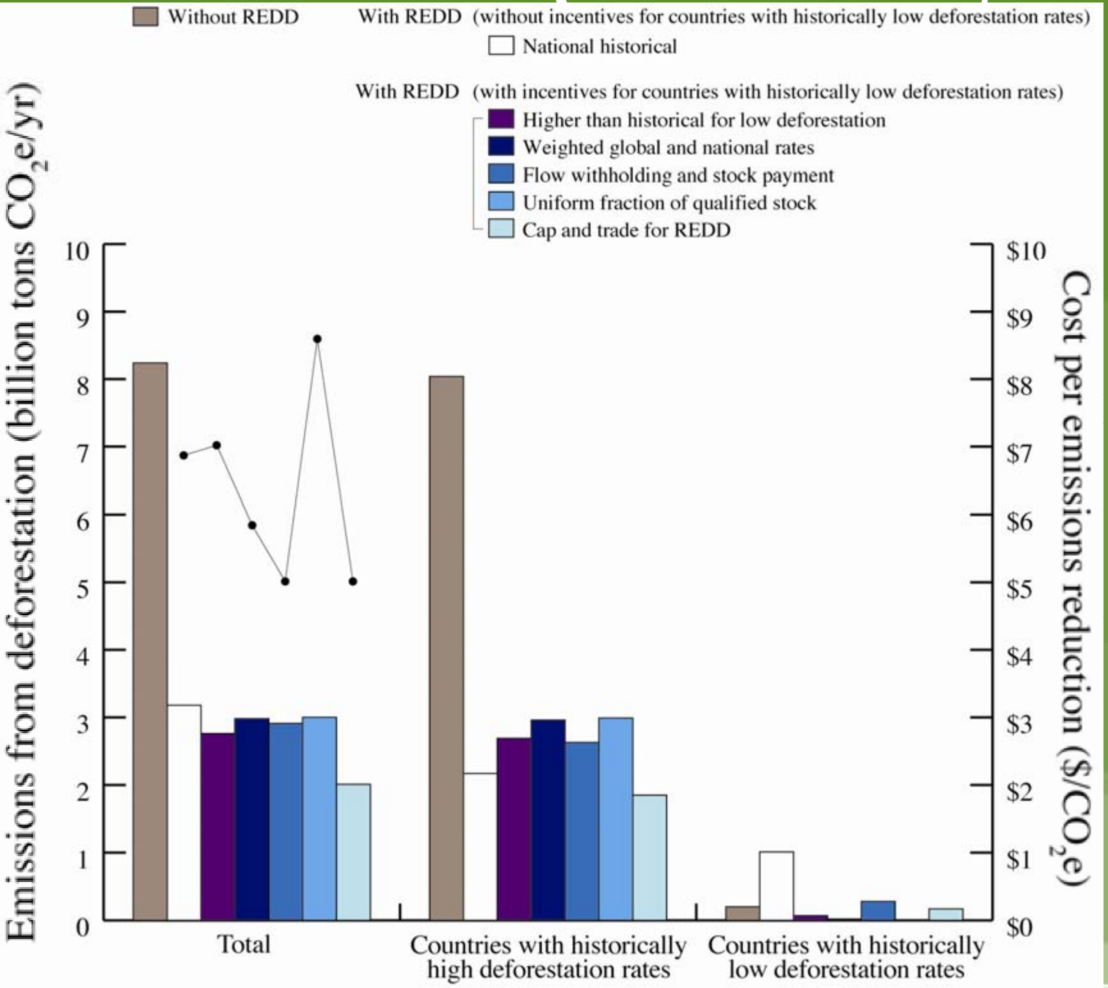
- Caveat: Model designed to compare mitigation and financial impacts across REDD+ designs, rather than to predict absolute magnitude of impacts

REDD+ can be an effective, efficient source of emissions reductions under a broad range of designs (Busch et al, in review)



OSIRIS v2.0 Parameter values: CO_2 price=$5/ton CO_2; Permanence scale=1.00; Elasticity of demand=1.0; Social preference for REDD surplus = 1.00; Mgmt cost=$3.50/Ha/yr; Soil carbon eligible=0.25; Baseline for low defor=0.003; Weight on historical=0.40; Stock-flow withholding=0.40; At-risk land=0.80; Baseline as % of at-risk land=0.10

Extending REDD+ incentives to all countries reduces leakage, making REDD+ mechanism more effective overall (Busch et al, in review)



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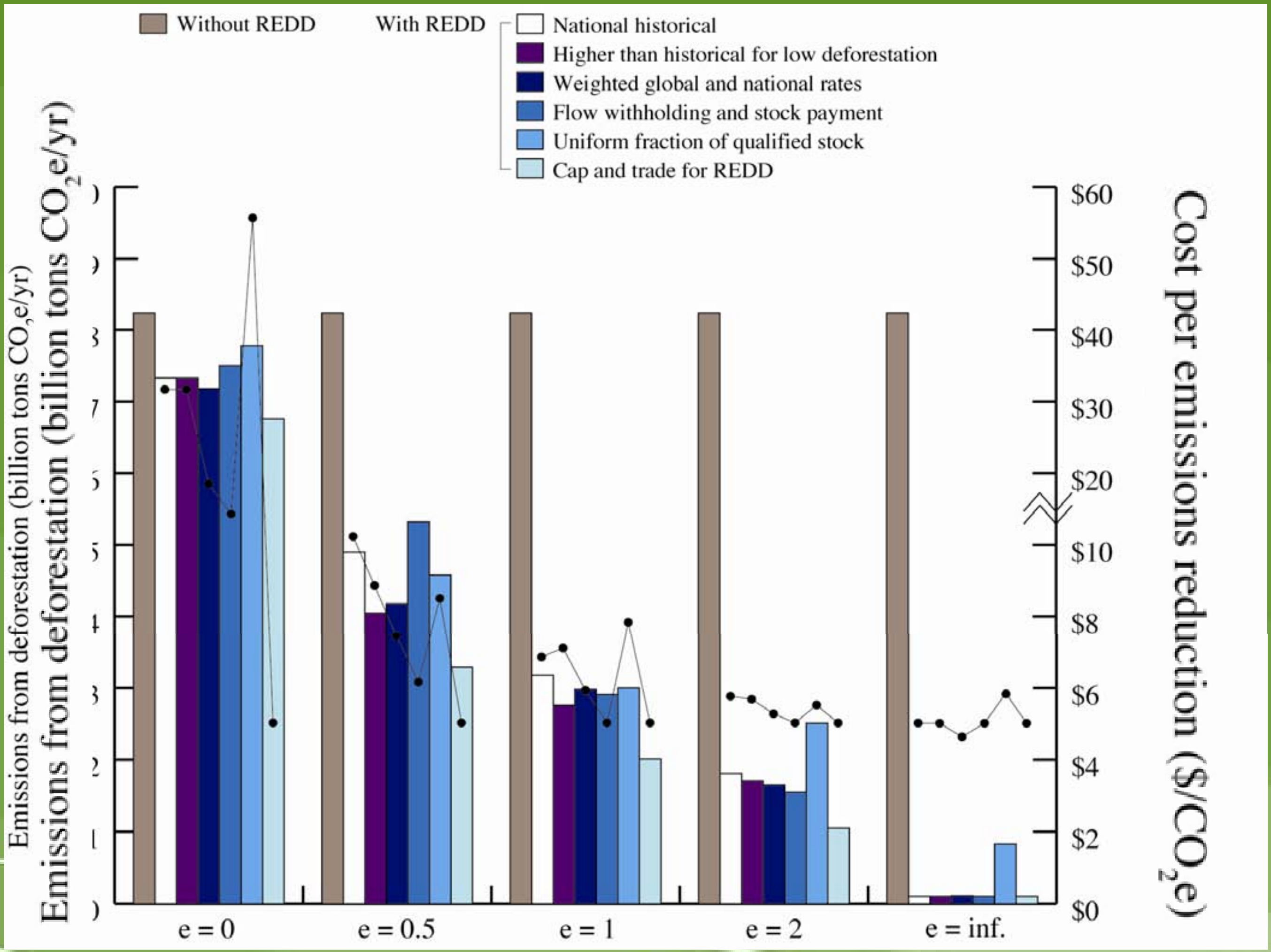
REDD+ effectiveness can be increased by meeting agricultural needs off the frontier (Busch et al, in review)



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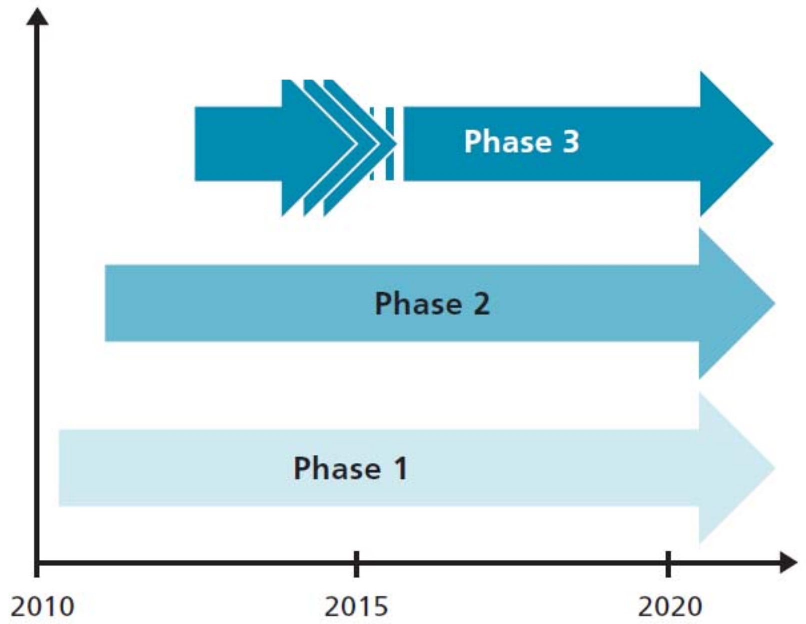
The process for setting reference levels

(Angelsen et al, 2009)

Figure 2.1: Suggested timing for phasing in support mechanism for REDD action



Phase 1: Capacity building and MRV

Phase 2: Fund-based demonstration activities

Phase 3: Market compensation for reductions below reference levels

Options for setting RLs:

1. RL table negotiated at COP
2. Over time, parties propose RLs to SBSTA
3. Over time, parties propose RLs to UNFCCC committee, with external expert assessment
4. Over time, parties propose RLs to SBSTA, with external expert assessment

Next steps leading to UNFCCC COP 15

- REDD+ designs of interest to parties
- Impacts of REDD+ incentives to 2050 (with IIASA)
- Market vs. fund vs. quota
- Distribution and equity
- Co-benefits of REDD+ (development, water, biodiversity)
- Staged implementation of REDD+ by countries
- Downscaled analyses in key countries (Madagascar, Liberia, Peru, Guyana, Suriname, Indonesia, Brazil)

Key Messages

- REDD+ can be an effective, efficient source of emissions reductions under a broad range of reference level designs.
- Extending REDD+ incentives to countries with historically low deforestation rates can prevent leakage to those countries, making the REDD+ mechanism more effective overall.
- The overall effectiveness of REDD+ can be increased by meeting agricultural needs off the tropical forest frontier.

- OSIRIS is a free, transparent, accessible open-source decision support spreadsheet tool designed to support UNFCCC negotiations on REDD+:

http://www.conservation.org/osiris

Thank You!

Collaborators:

Conservation International
Environmental Defense Fund
The Woods Hole Research Center
University of East Anglia
Terrestrial Carbon Group

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David and Lucile Packard Foundation

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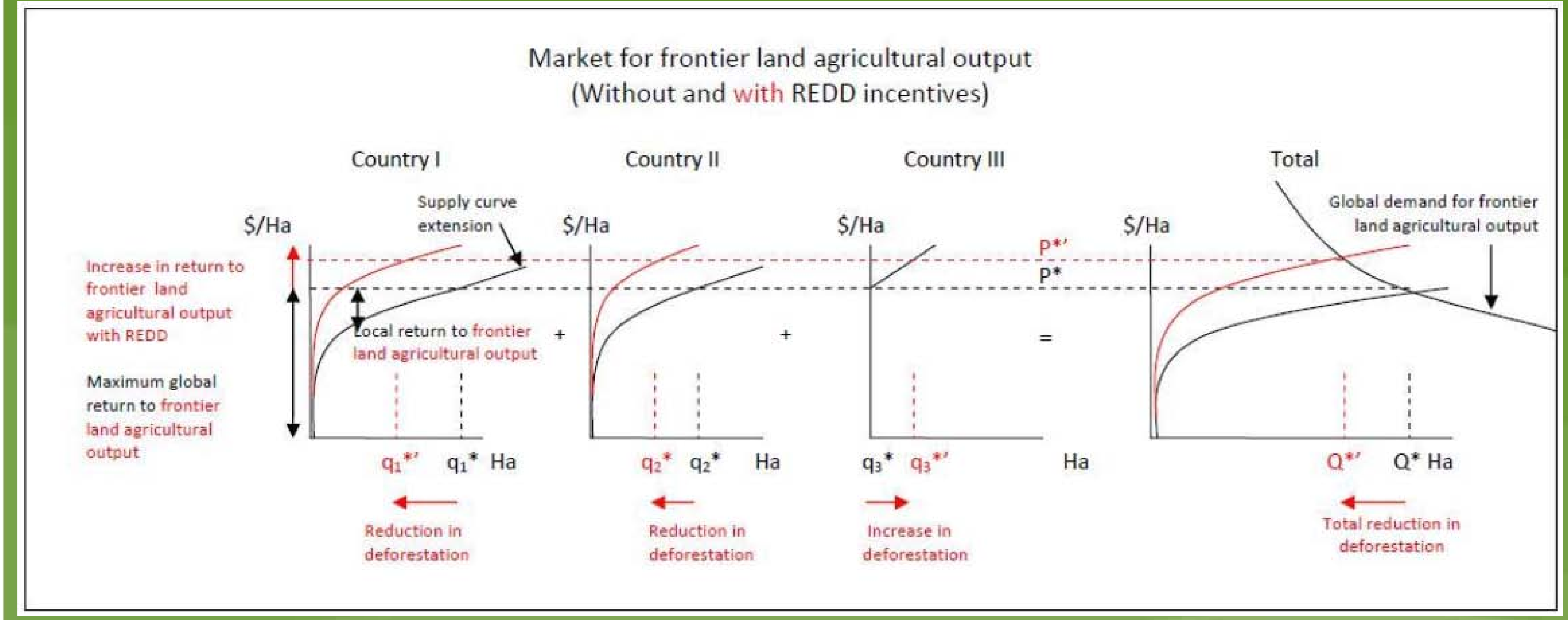
Data

- Forest cover loss rates, 2000-2005 (FAO FRA, 2005)
- Forest cover, 2005 (FAO FRA, 2005)
- Forest carbon density (Ruesch and Gibbs, 2008)
- Soil carbon density (GSDTG, 2001)
- Gross agricultural returns (Fischer *et al*, 2000; Naidoo and Iwamura, 2007; Strassburg *et al*, 2008; Schmitt *et al*, 2008)
- Timber returns (Sohngen and Tennity, 2004)
- Management costs (James *et al*, 2001)

Endogenous leakage in a partial equilibrium model

(Busch et al, in review; adapted from Murray, 2008)

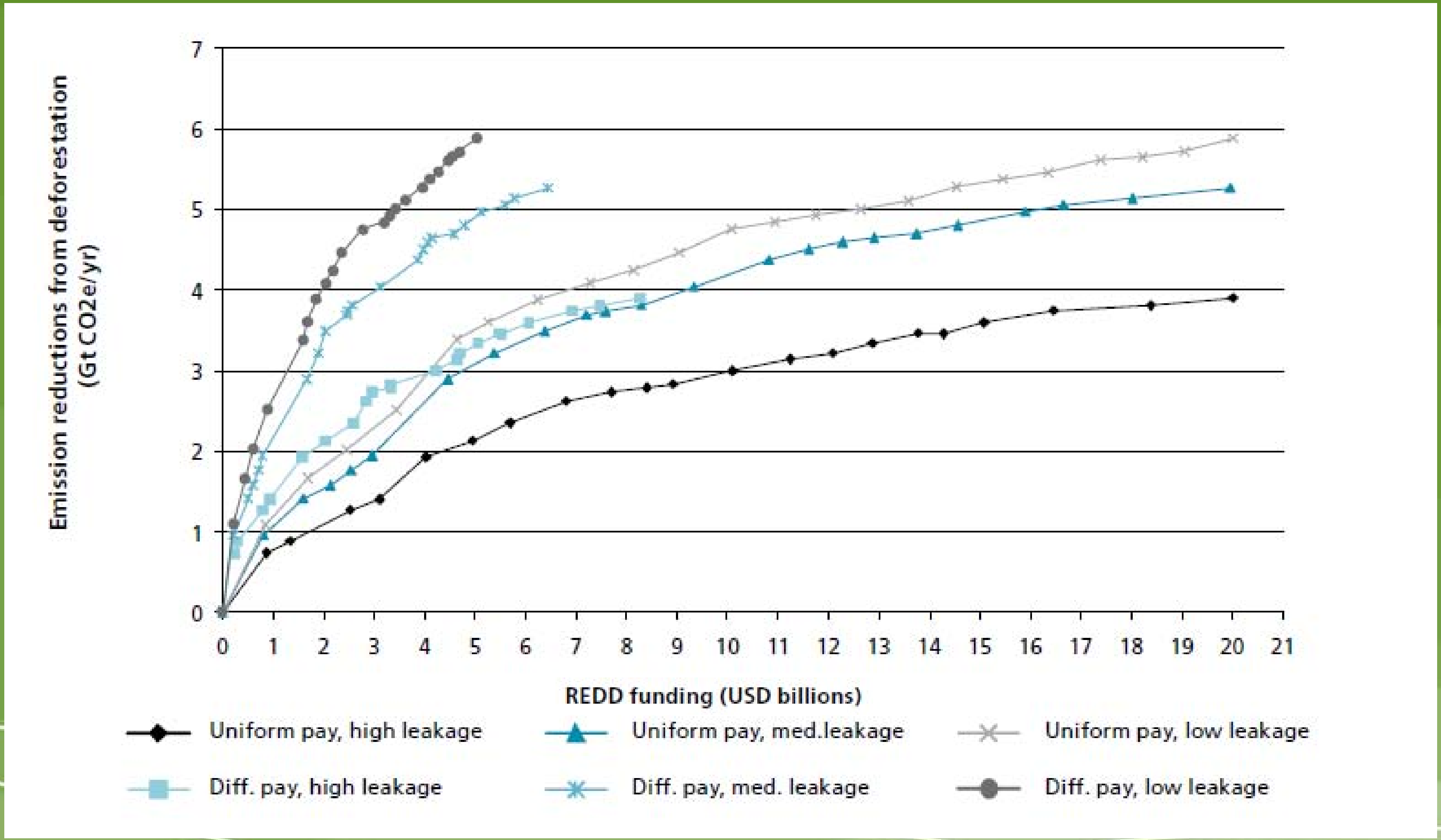


Scope of analysis

- Single period model only—dynamic effects not included
- Agriculture and timber only—mining not included
- Forests and soil only—other carbon stocks not included
- Deforestation only—degradation, A/R, SFM not included
- Historical, rather than projected, business as usual

- Caveat: Model designed to compare impacts across REDD designs, not to predict absolute magnitude of impacts

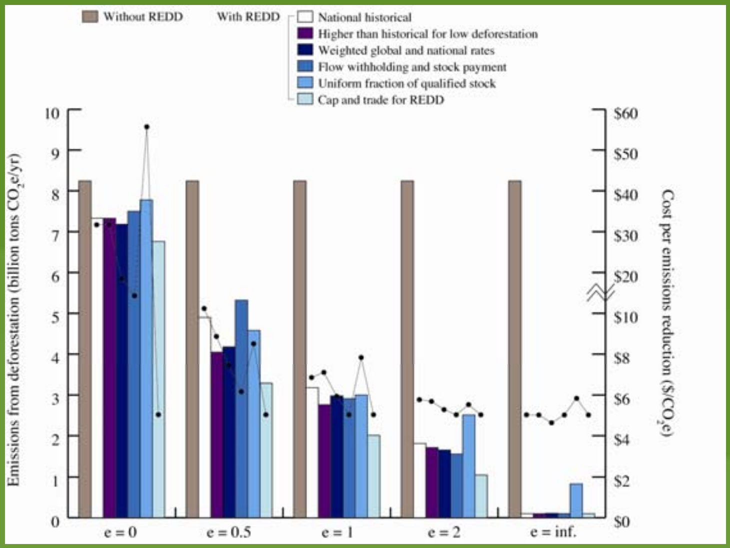
Quantity of emissions reductions available from REDD at given levels of funding (Angelsen et al, 2009)

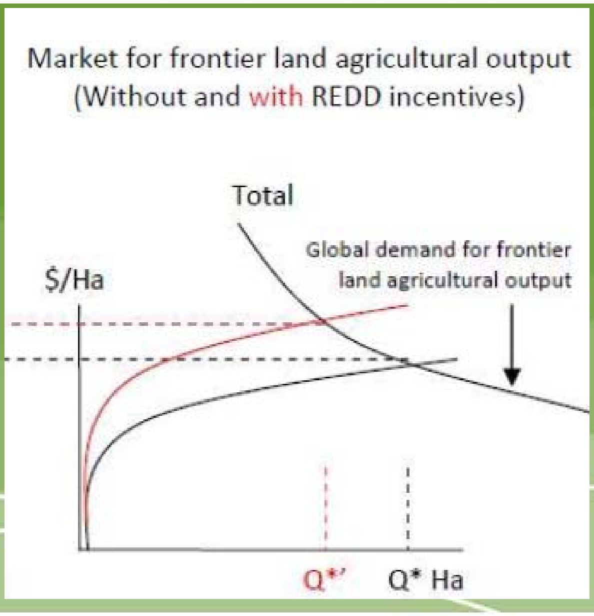


OSIRIS vOAR Parameter values: Social preference for REDD surplus = 1.00; Mgmt cost=$3.50/Ha/yr; Soil carbon eligible=0.10

“Finger snap” improvement: elasticity

- Price elasticity of demand for food calories can not be distinguished from perfectly inelastic (Roberts and Schlenker, 2009)
- Price elasticity of demand for food crops (Seale, Regmi, and Bernstein, 2003):
  - Developed: -0.1 to -0.5
  - Developing: -0.3 to -0.8
- But, market share of frontier agriculture is small…

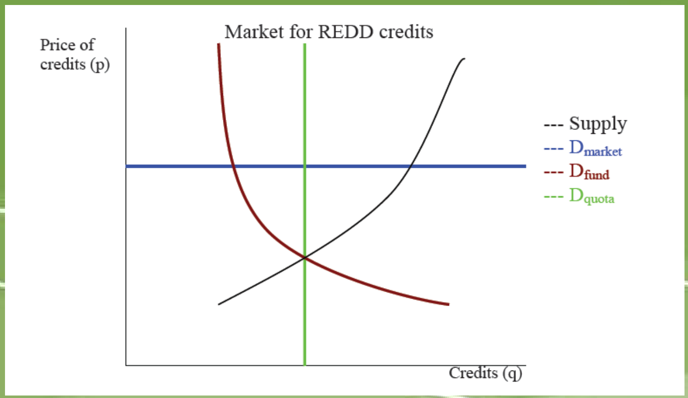


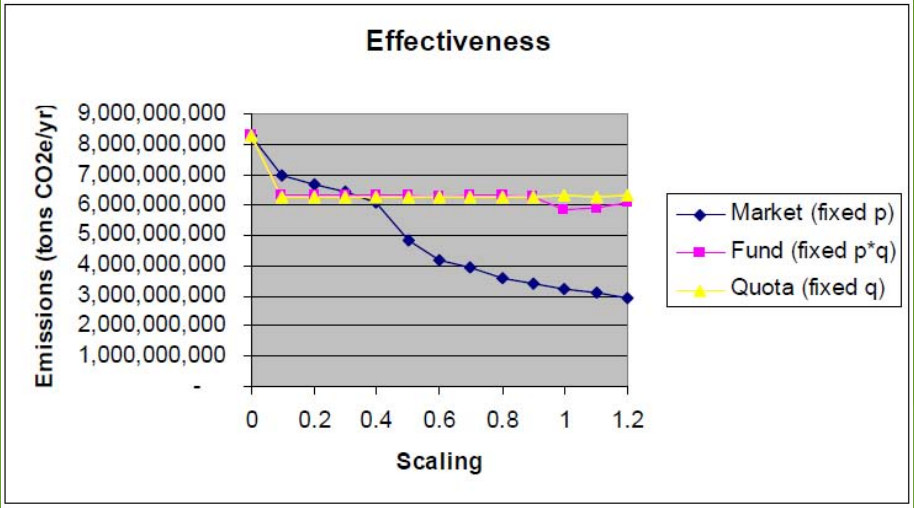


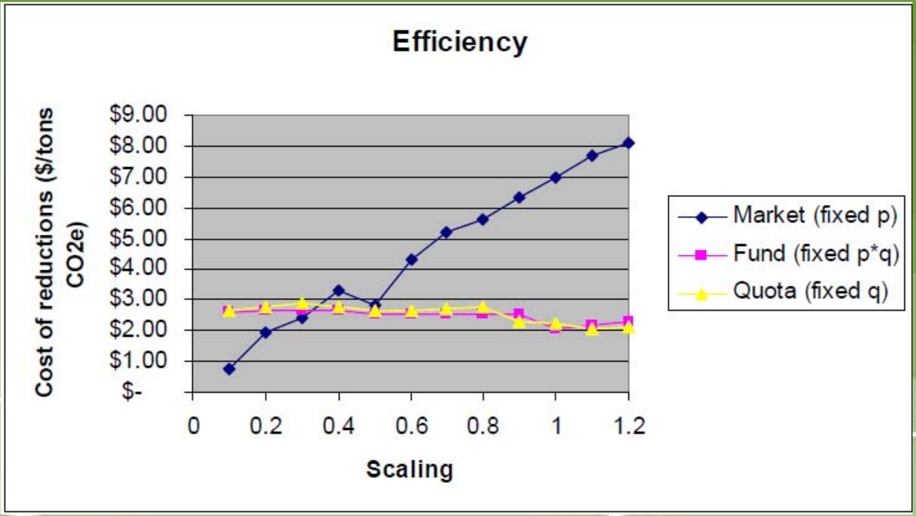
Market, fund or quota

(Busch, Angelsen, and Cattaneo; working paper)

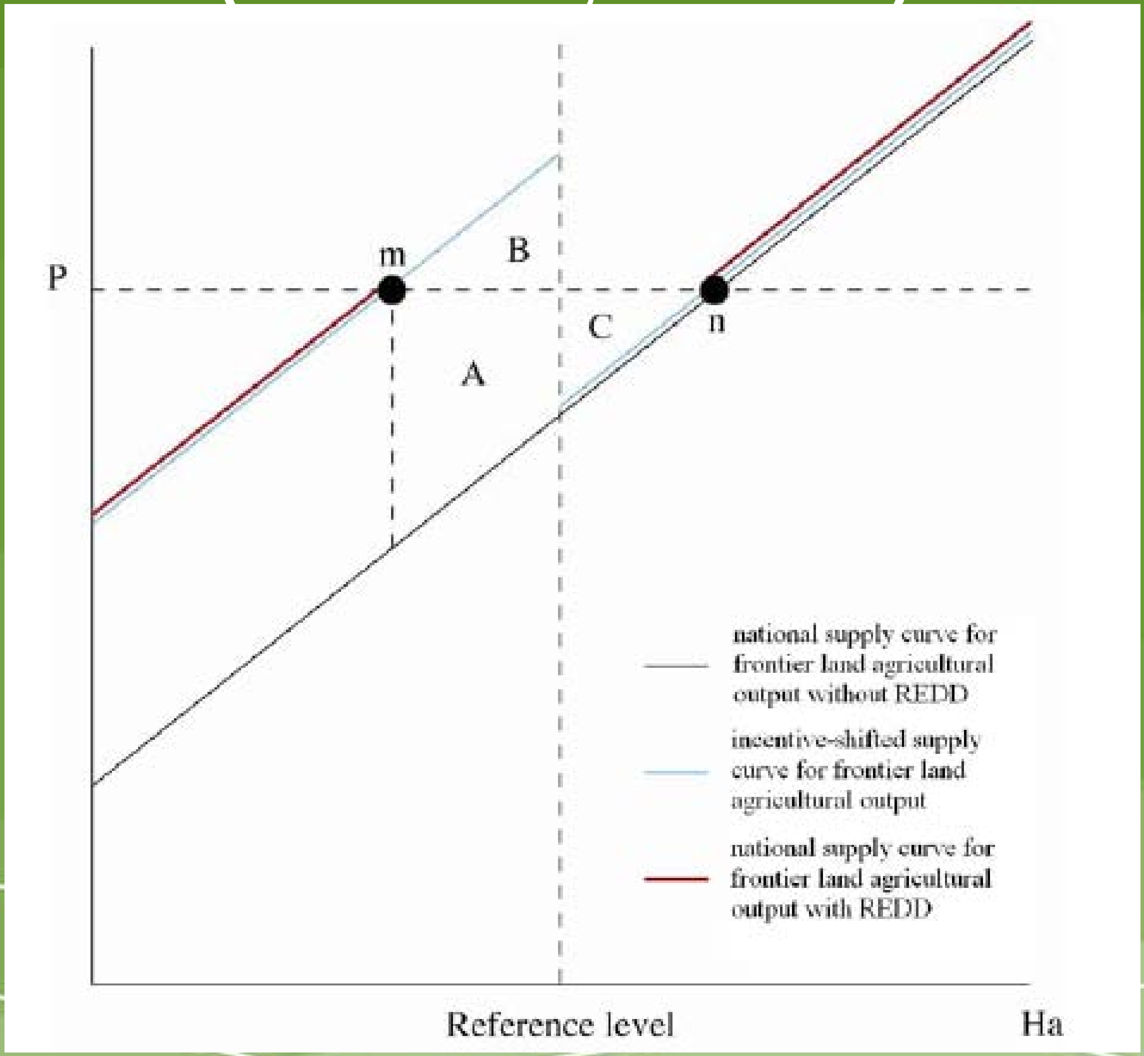
- Three model setups:
  - Market (fixed p)
  - Fund (fixed p*q)
  - Quota (fixed q)
- In a market, scaling down national RELs decreases effectiveness and increases efficiency
- In a fund, scaling down national RELs has ambiguous/neutral impact on effectiveness and efficiency



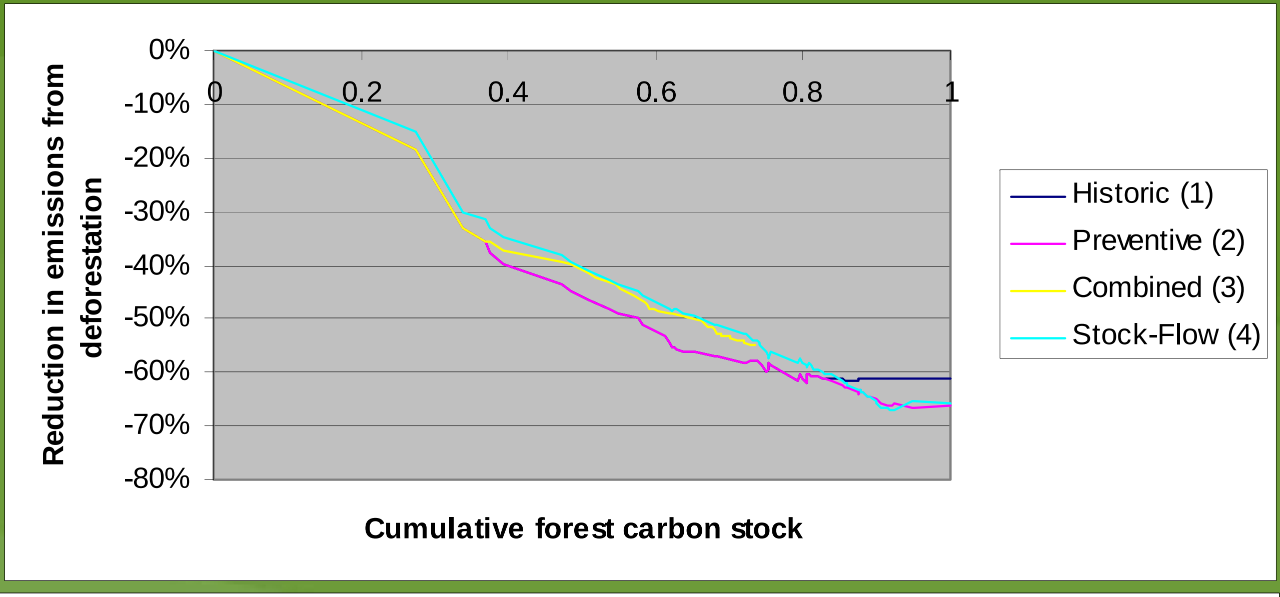


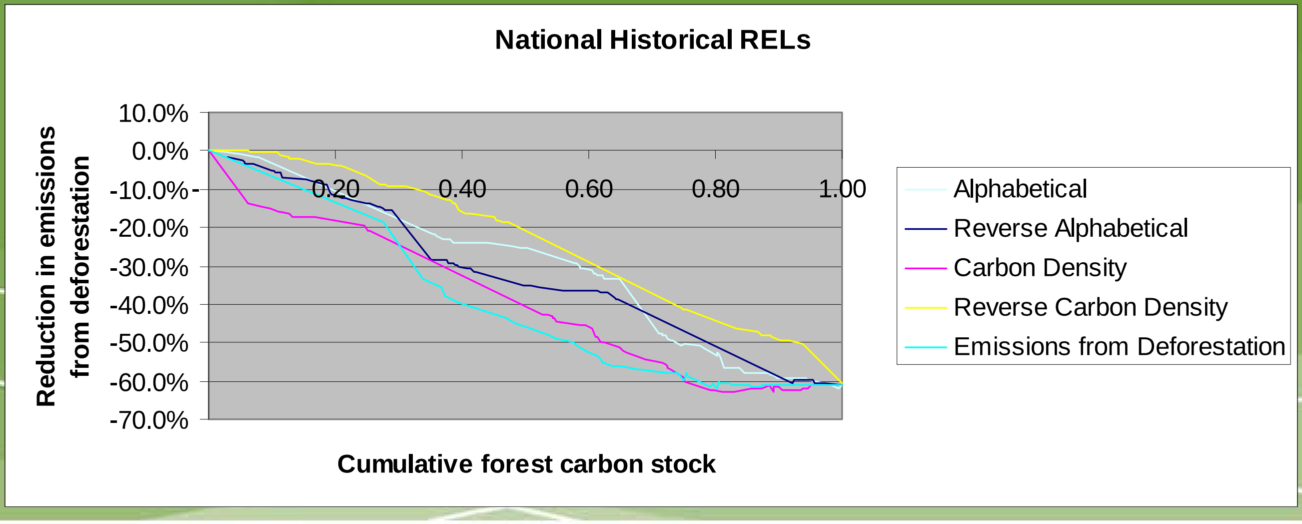


Carbon price and reference level determine national rate of deforestation
(Busch et al, in review)



Incomplete participation (Busch et al 2009; preliminary)





Cost to half global emissions from deforestation

Design option	Reference	Cost to half emissions (2008 US$billion/yr)
"National historical"	Santilli *et al* (2005)	18.1
"Higher than historical for countries with low deforestation rates"	Mollicone *et al* (2007); da Fonseca *et al* (2007)	14.7
"Weighted average of national and global"	Strassburg *et al* (2008)	15.6
"Flow withholding and stock payment"	Cattaneo *et al* (2008)	11.0
"Uniform fraction of qualified stock"	Ashton *et al* (2008)	25.6
"Cap and trade for REDD"	Eliasch (2008); For comparison only	8.1
"Pure stock approach"	For comparison only	2716.9

OSIRIS v2.2 Parameter values: Permanence scale=1.00; Elasticity of demand=1.0; Social preference for REDD surplus = 1.00; Mgmt cost=$3.50/Ha/yr; Soil carbon eligible=0.25; Baseline for low defor=0.003; Weight on historical=0.40; Stock-flow withholding=0.40; At-risk land=0.80; Baseline as % of at-risk land=0.10

Proposed avenues for collaboration

- OSIRIS contributions:
  - Ability to model impact of REDD design incentives
  - Endogenous leakage
  - Flexible parameters and assumptions
  - Transparent, open source, click-of-a button interface

- Seeking collaboration:
  - Data (especially degradation, A/R)
  - Alternative opportunity cost curves (including future scenarios)
  - Demand-side modeling for agriculture and timber

Deforestation causes ~17% of global greenhouse gas emissions

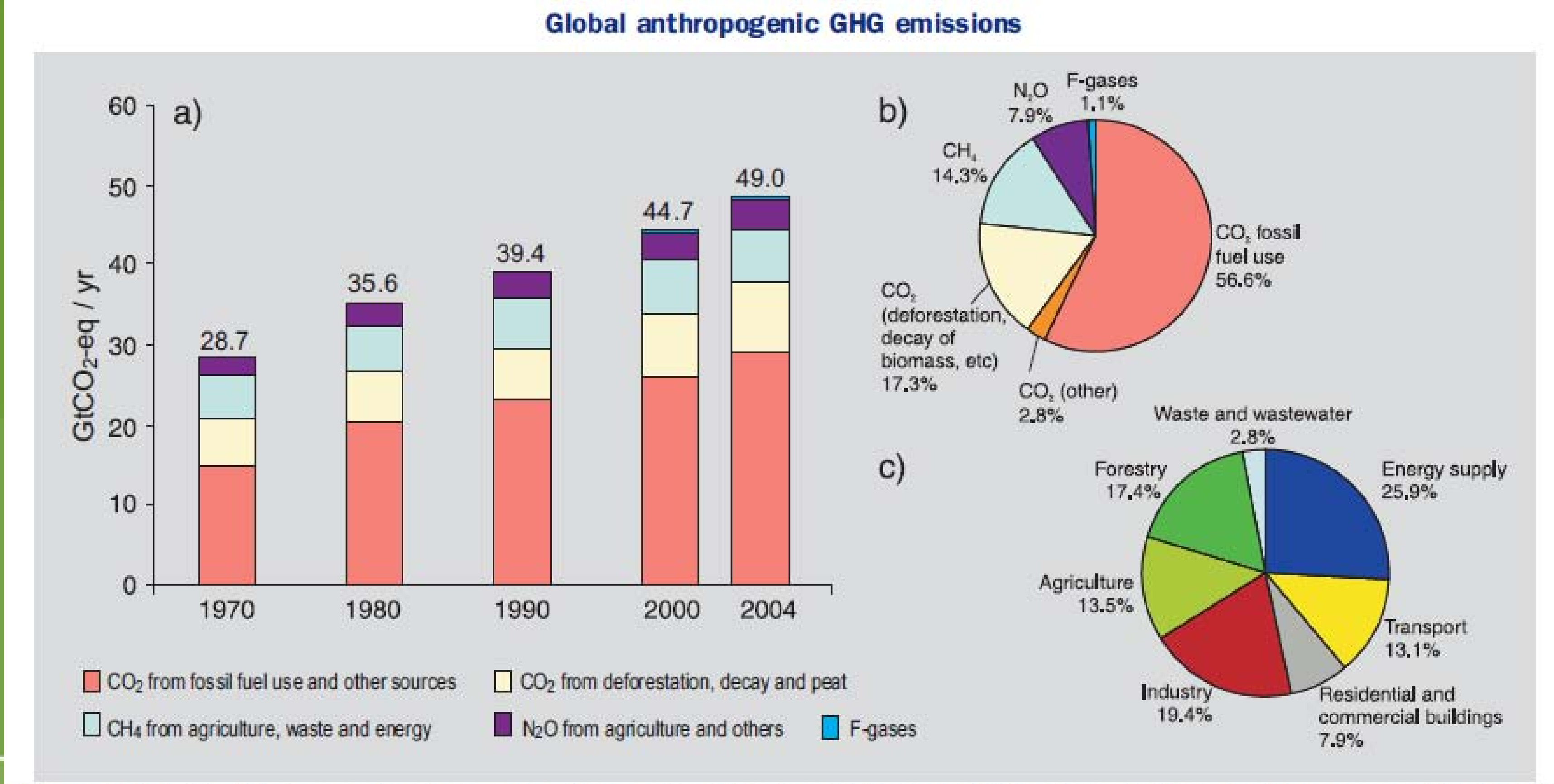
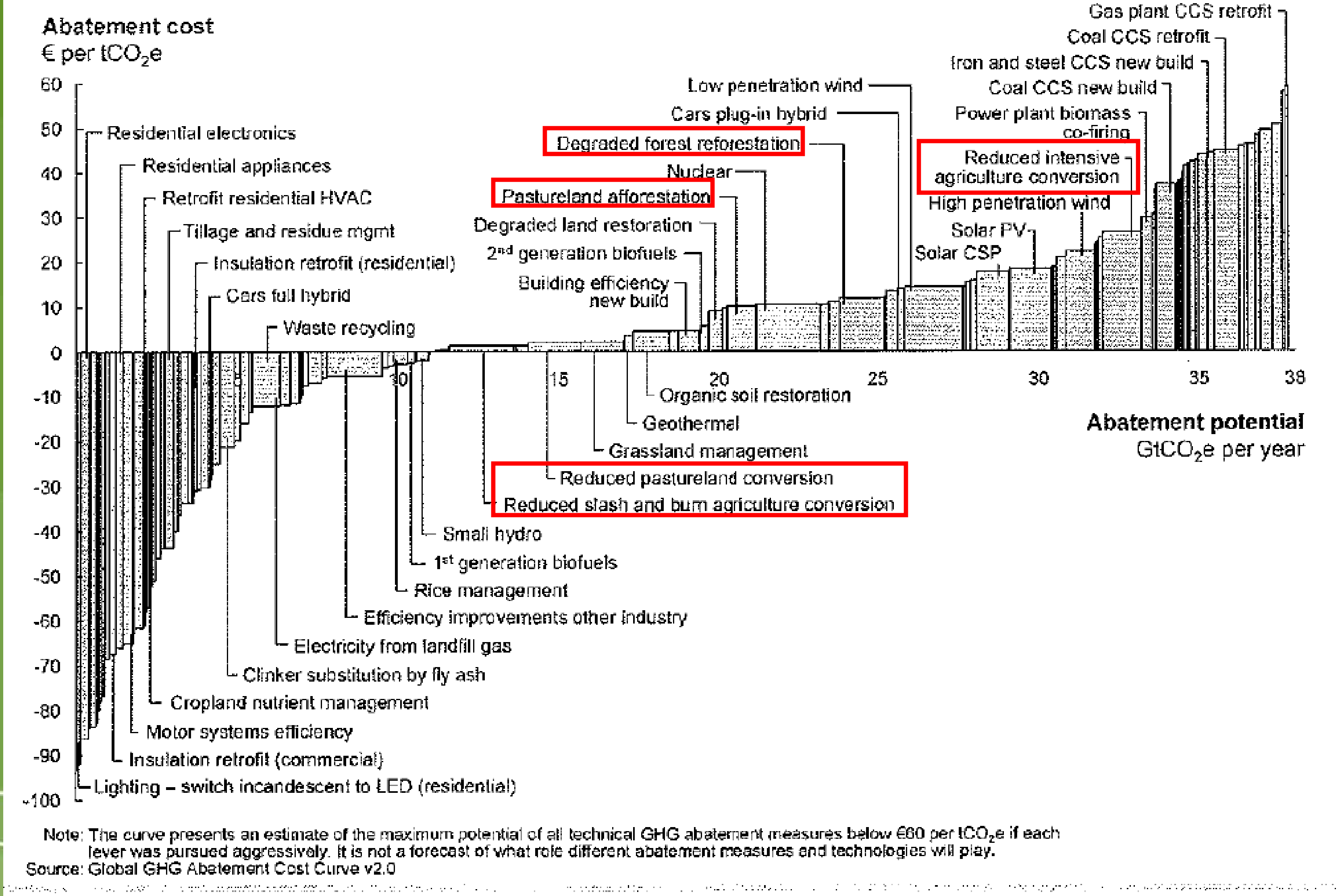


Figure SPM.3. *(a) Global annual emissions of anthropogenic GHGs from 1970 to 2004.[5] (b) Share of different anthropogenic GHGs in total emissions in 2004 in terms of carbon dioxide equivalents (CO_2-eq). (c) Share of different sectors in total anthropogenic GHG emissions in 2004 in terms of CO_2-eq. (Forestry includes deforestation.) {Figure 2.1}*

Source: IPCC 4AR, Executive Summary, Figure SPM.3

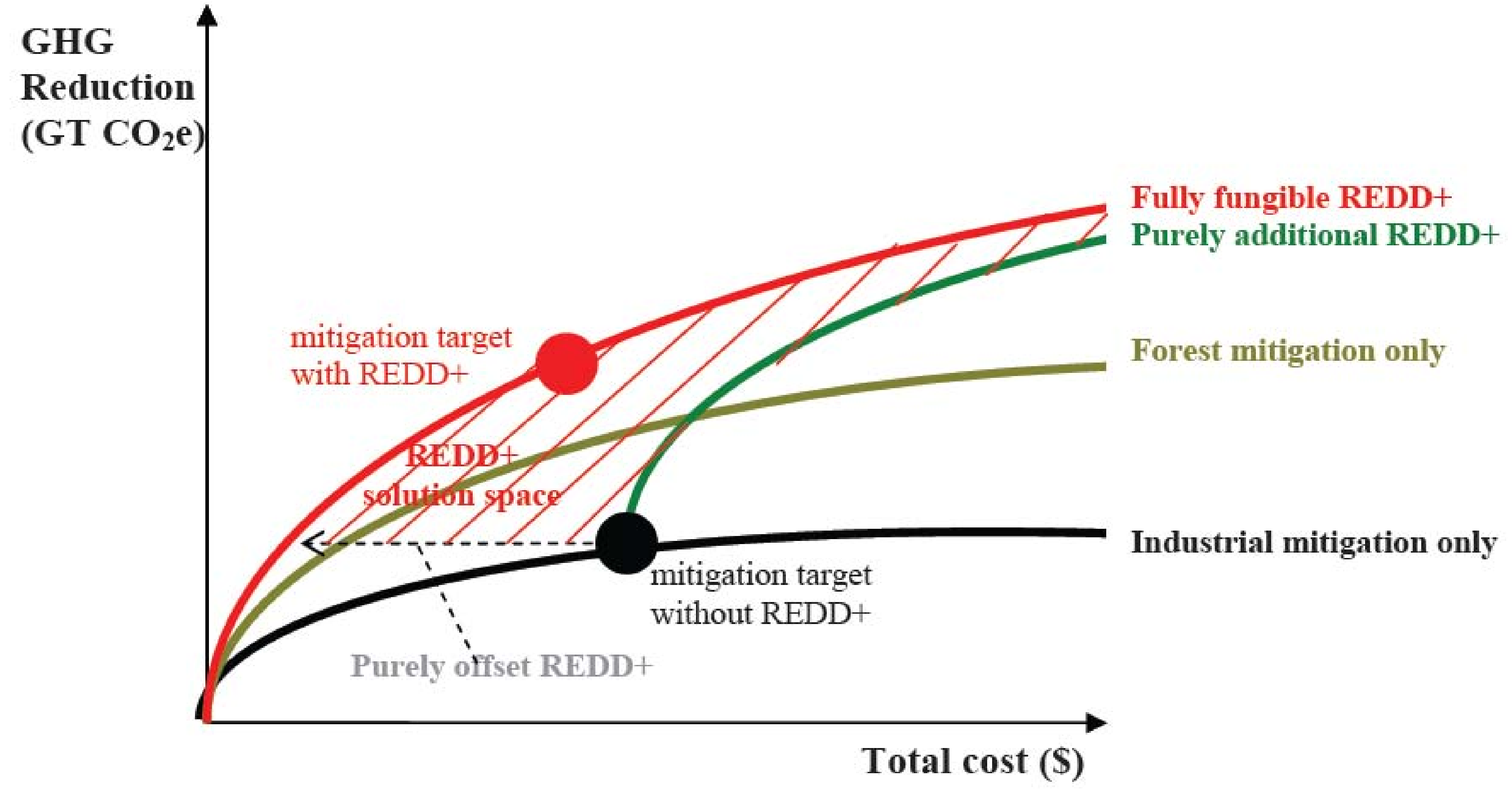
McKinsey GHG Abatement Cost Curve



Source: Naucler and Enkvist, 2009

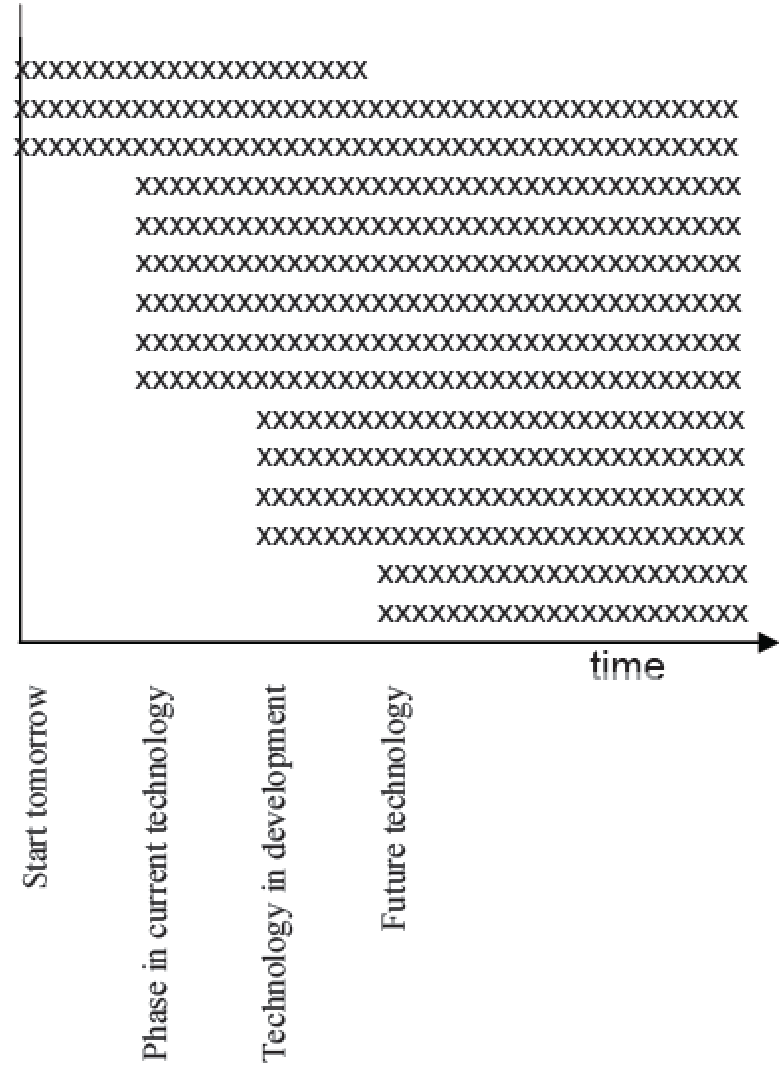
Achieving greater reductions at lower cost with REDD+

(Busch, Angelsen, and Cattaneo; working paper)

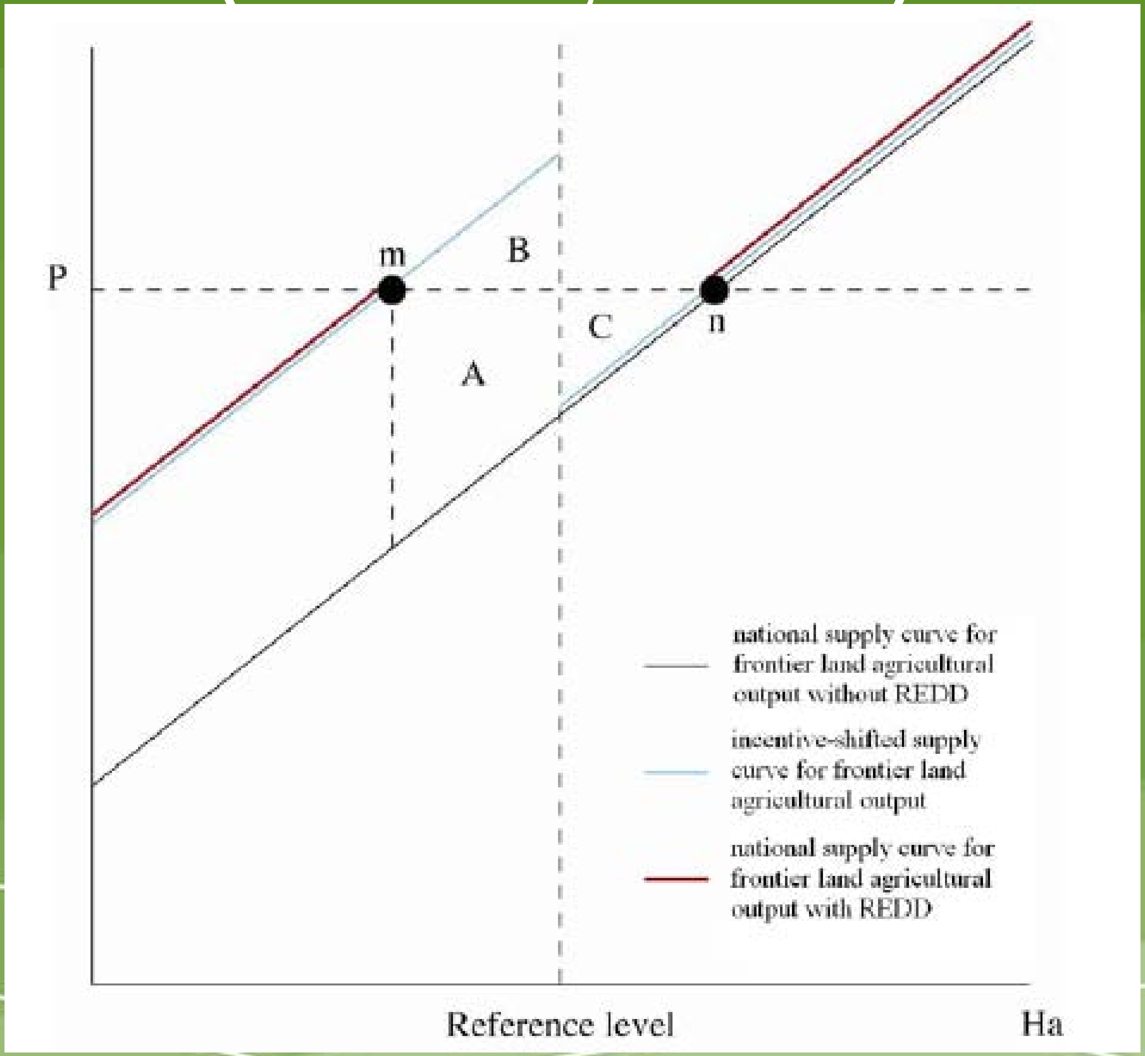


Timing of potential deployment of mitigation wedges
(preliminary; adapted from Pacala and Socolow, 2004)

1. REDD+
2. Reduced use of vehicles
3. Conservation tillage
4. Efficient vehicles
5. Efficient buildings
6. Efficient baseload coal plants
7. Gas baseload power for coal baseload power
8. Nuclear power for coal power
9. Wind power for coal power
10. Capture CO2 at baseload power plant
11. PV power for coal power
12. Wind H2 in fuel-cell car for gasoline in hybrid car
13. Biomass fuel for fossil fuel
14. Capture CO2 at H2 plant
15. Capture CO2 at coal-to-synfuels plant+geological storage



Carbon price and reference level determine national rate of deforestation (Busch et al, in review)



Supply curves for frontier land agricultural and timber output

$$p_j = (\pi \sum_{n=1}^{N} r_{ij}^{(1-\delta)^n}) + t_i$$

- p_{ij} = net present value of agriculture and timber in country *i* on hectare *j*
- π = profit margin = 0.15 (net return = 0.15 * gross return) (following Stern, 2007)
- r_{ij} = maximum gross annual return to agriculture in country *i* on hectare *j* (Fischer et al, 2000; Naidoo and Iwamura, 2007; Strassburg et al, 2009)
- *N* = 30 year time horizon (following Stern, 2007)
- δ = discount rate = 0.10 (following Stern, 2007)
- t_i = once-off value of timber in country *i* (Sohngen and Tennity, 2004)

- NPVs calculated across all forest area in country (spatial), then scaled to FAO net forest cover loss area (non-spatial)