The Economics of Pollution, Part I:

Damage and Abatement at the Margin

David Possen
DIS Environmental Economics

Plan of this lecture

1. Cost-benefit analysis: quick recap
2. Rethinking supply and demand
3. “Pollution services”: costs and benefits
4. Working with MD and MAC curves
5. How to aggregate (add) MAC curves
6. Preview (if time):
   the equimarginal principle

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1. Cost-benefit analysis: quick recap

1. Defining the project or policy to be analyzed
2. Identifying impacts
3. Valuing impacts
4. Comparing benefits and costs
5. Issuing a policy recommendation

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Specify its main elements:
Location, timing, groups involved, connections to other programs, and baseline analysis.

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Specify inputs & outputs —and remember to include further-off outputs (implications of the likely outcomes)

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Value all impacts in terms of marginal social costs and benefits, in monetary (commensurable) terms; this requires discounting.

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This requires discounting, so that cost and benefit NPVs (net present values) can be compared to each other head-to-head.

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U.S. Federal law requires that regulations be adopted if and only if it can be demonstrated that benefits justify costs…

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2. Rethinking supply and demand

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Total cost

Marginal cost

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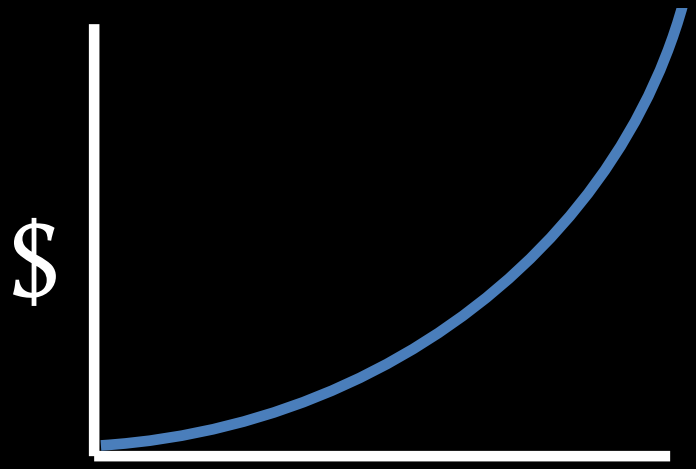

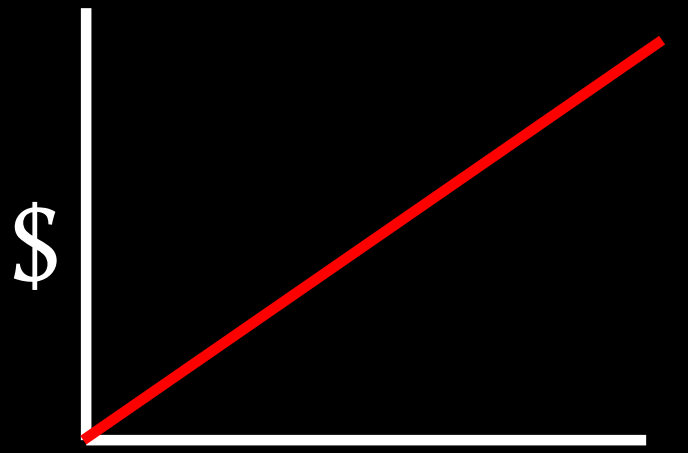

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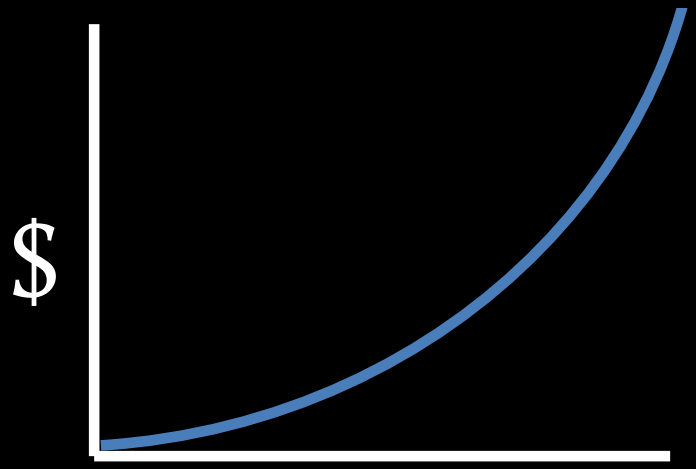

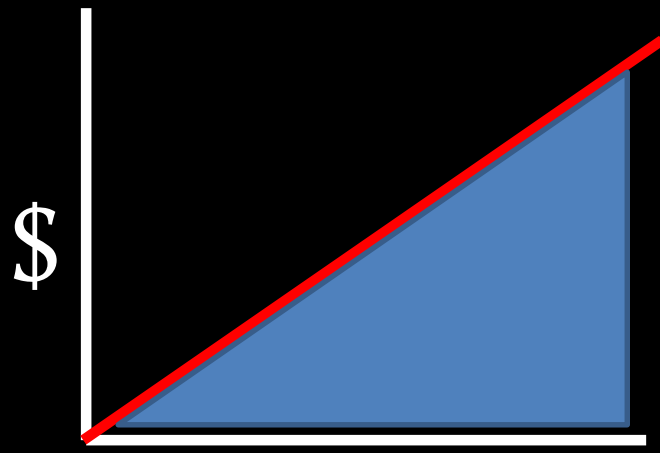

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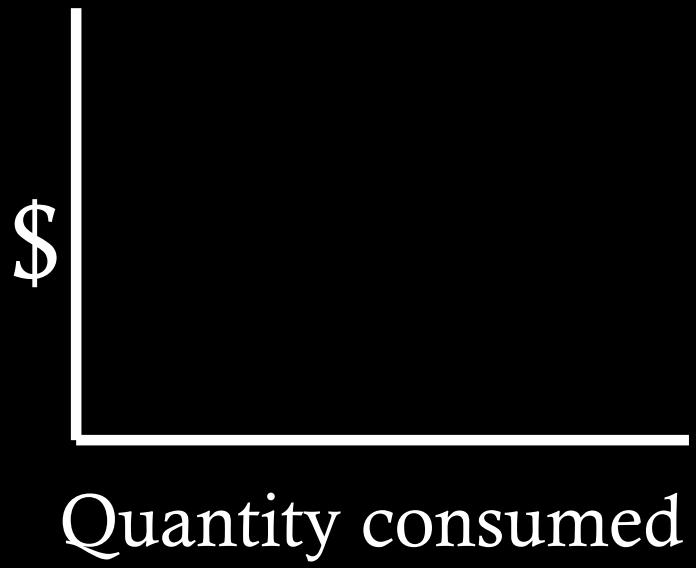

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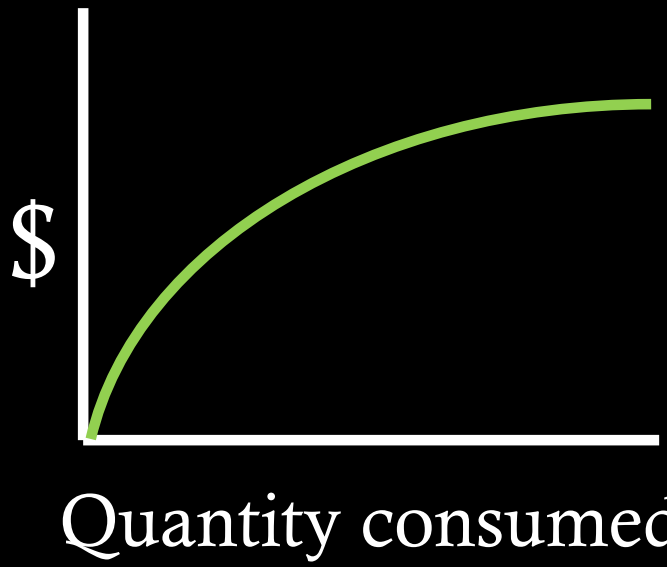

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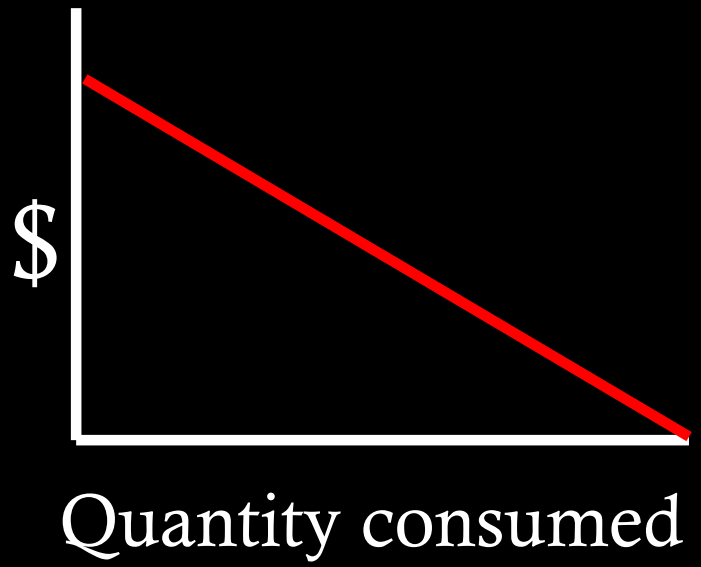

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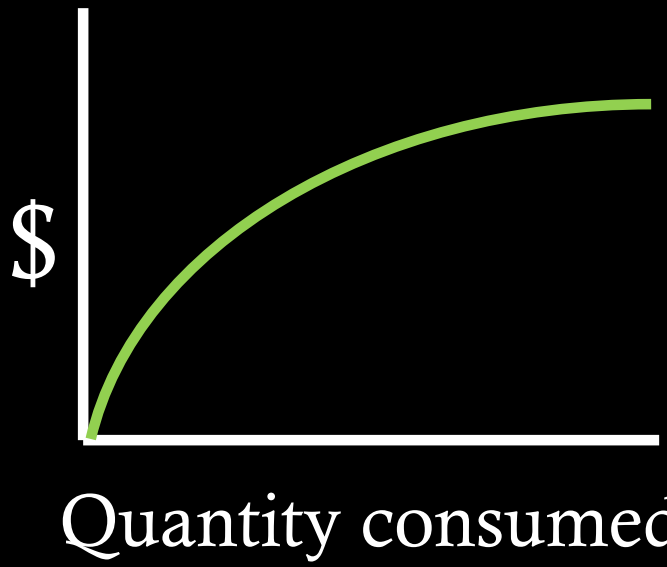

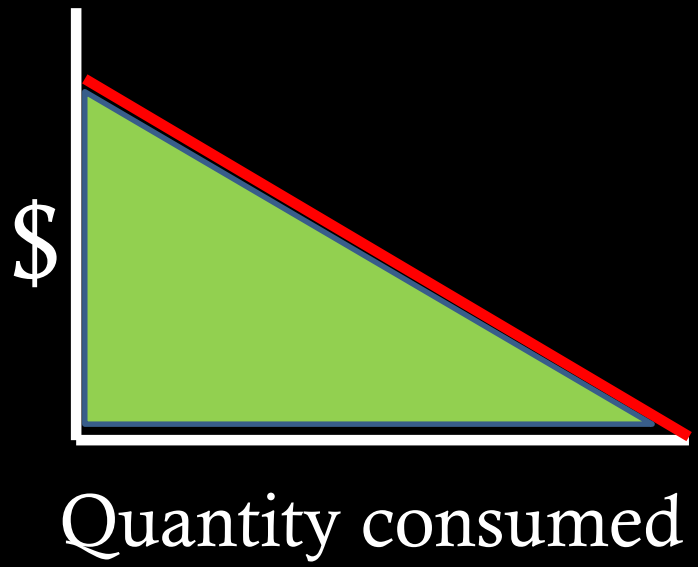

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not in terms of the harms it causes,
but in terms of the services it provides
to particular firms operating
within particular communities,
who can offer those firms “pollution services.”

3. “Pollution services”: costs and benefits

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For a given firm and community,
“pollution services” can be defined
as the value of additional production
made possible by
the community permitting the firm
to emit a given amount of pollutant.

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becomes something that
communities produce (supply to firms),
and that
firms consume (demand from communities).

3. “Pollution services”: costs and benefits

Now let’s take a closer look
at the supply and demand
of pollution services.

3. “Pollution services”: costs and benefits

The community’s supply of pollution services

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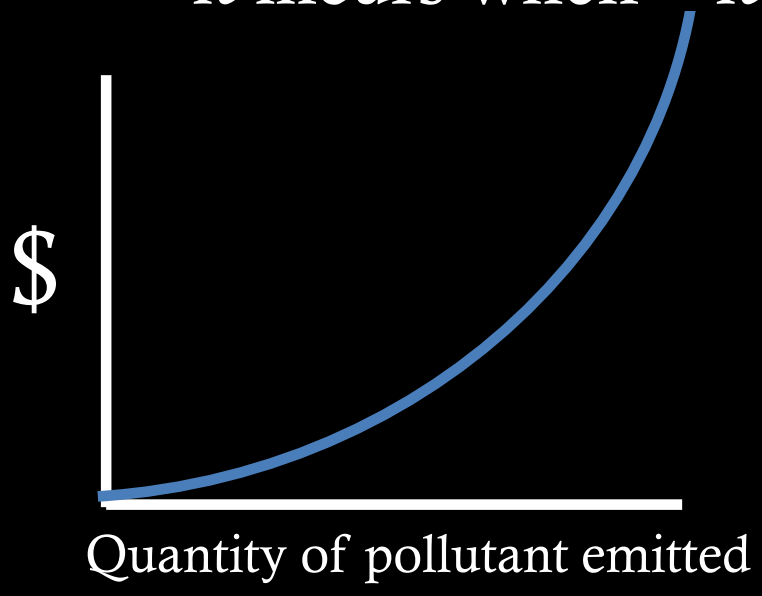
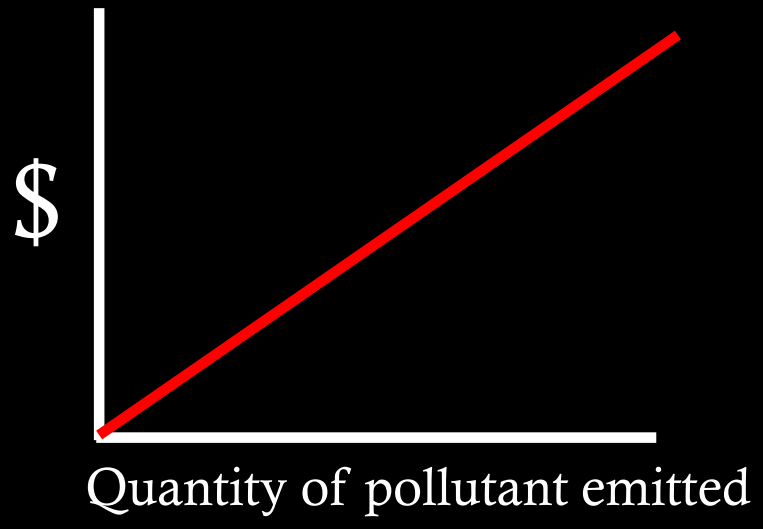
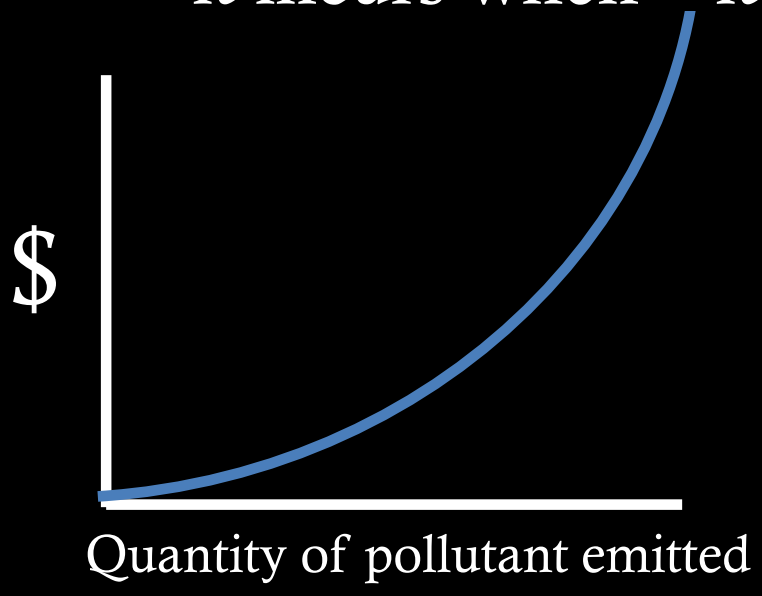


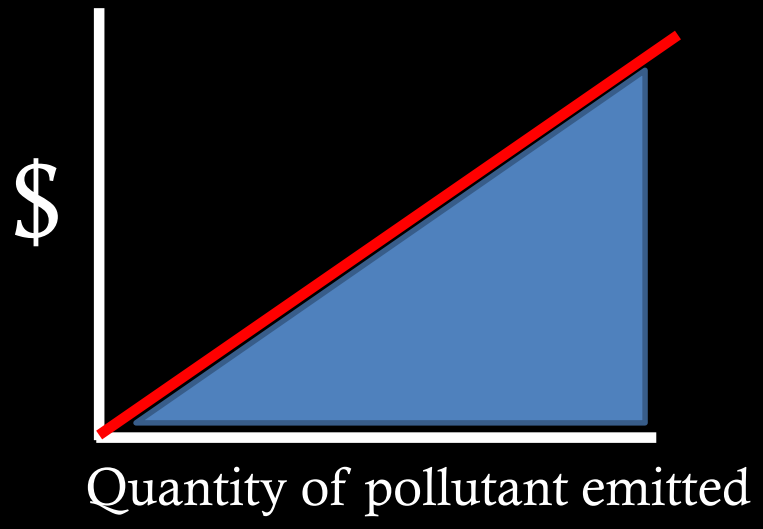


total damage cost **marginal damage cost**

3. “Pollution services”: costs and benefits

The community’s supply of pollution services is a function of the marginal damage costs it incurs when it lets the firm pollute more!





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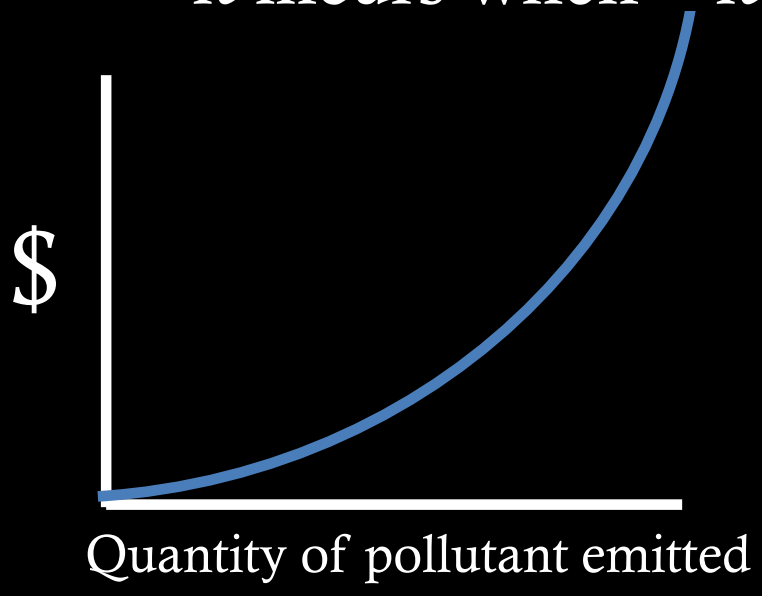
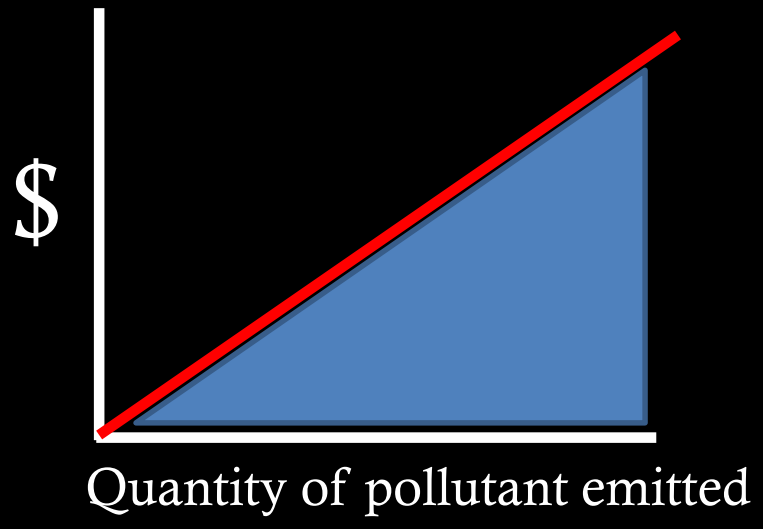


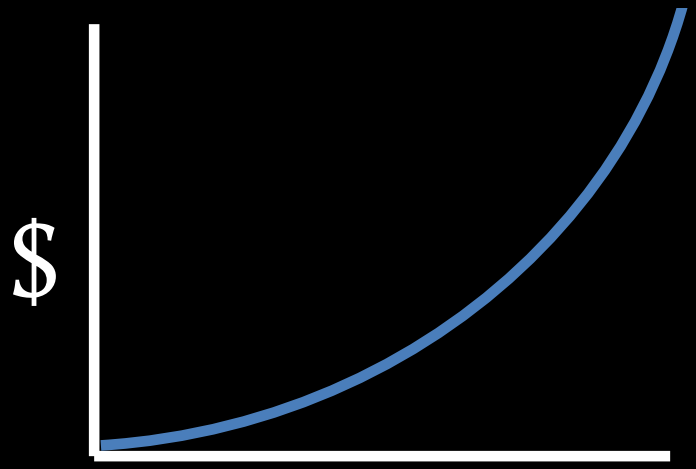


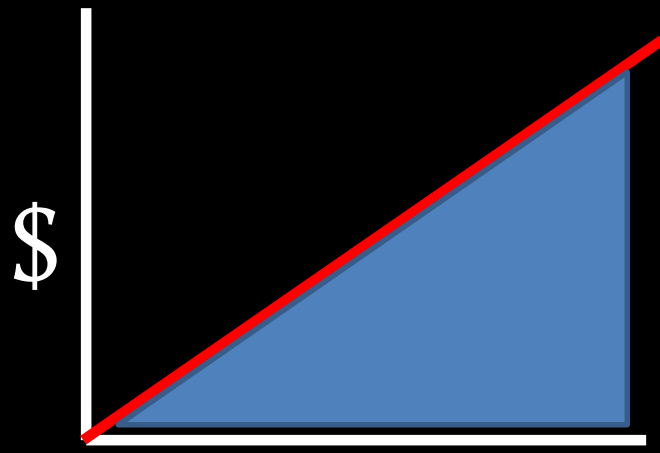
Supply of pollution services =

total damage cost **marginal damage cost**

Flashback!

A supply curve is a marginal cost curve





Total cost **Marginal cost**

3. “Pollution services”: costs and benefits

The firm’s demand for pollution services

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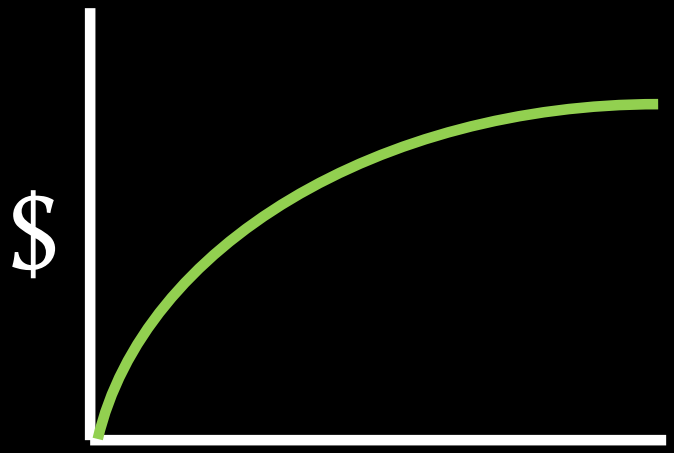
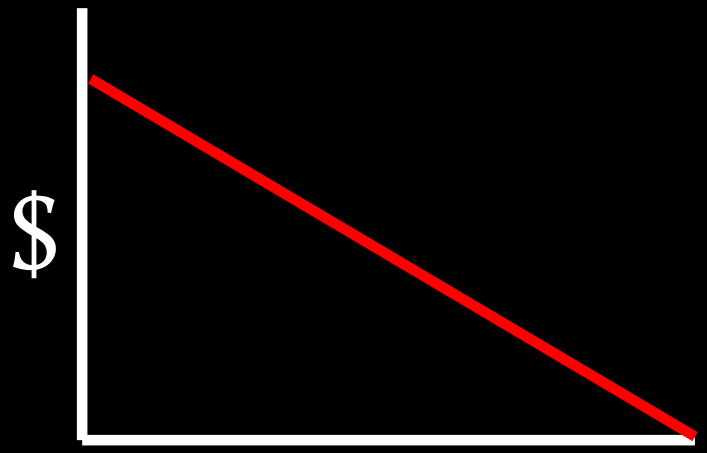


total benefits from polluting



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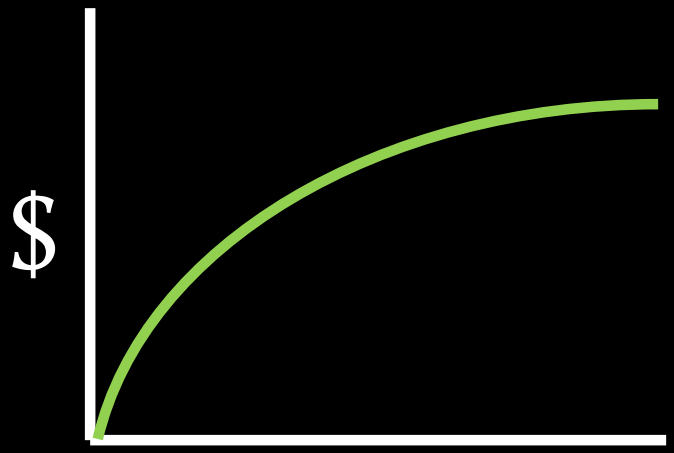

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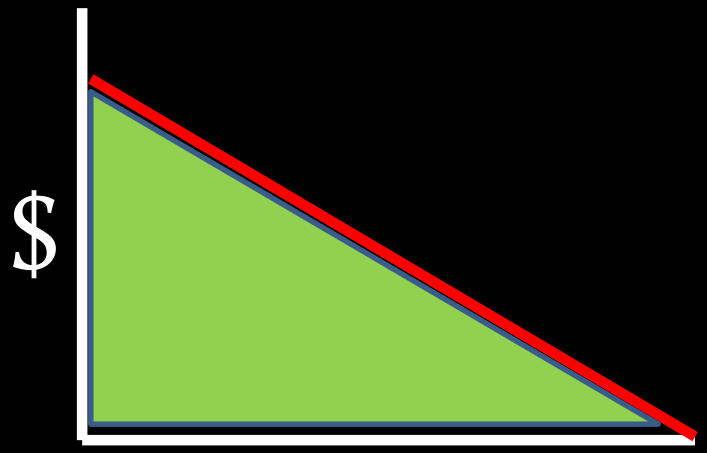

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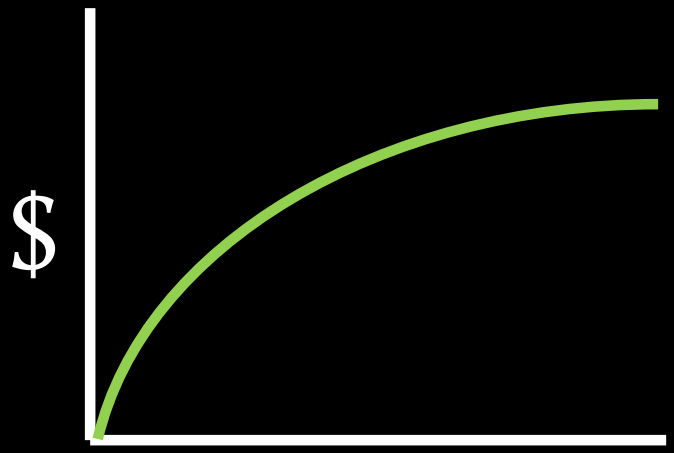

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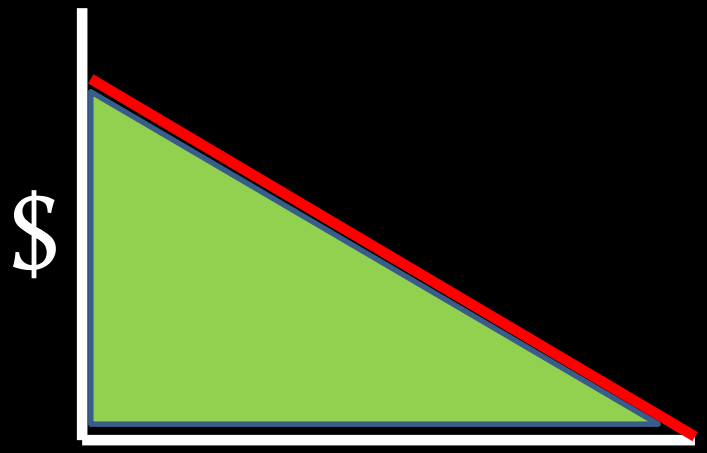

Demand for pollution services = marginal benefits from polluting

Flashback!

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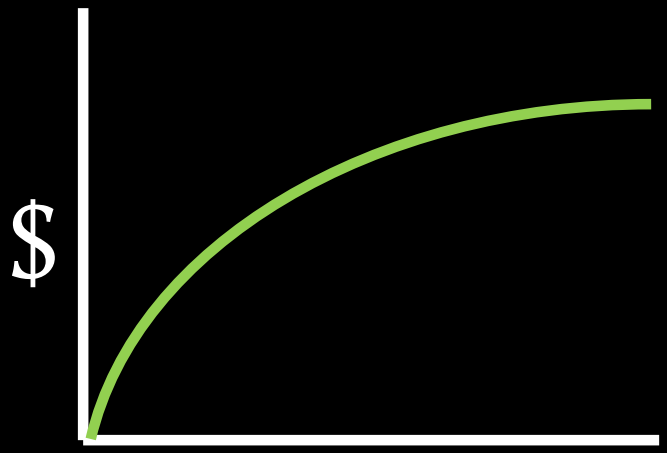
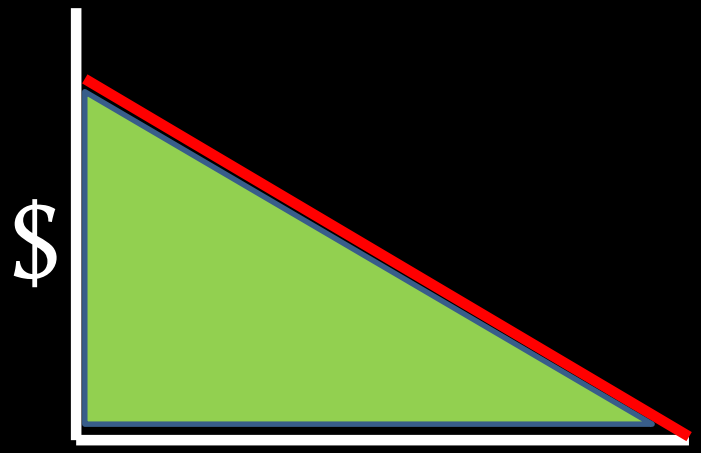


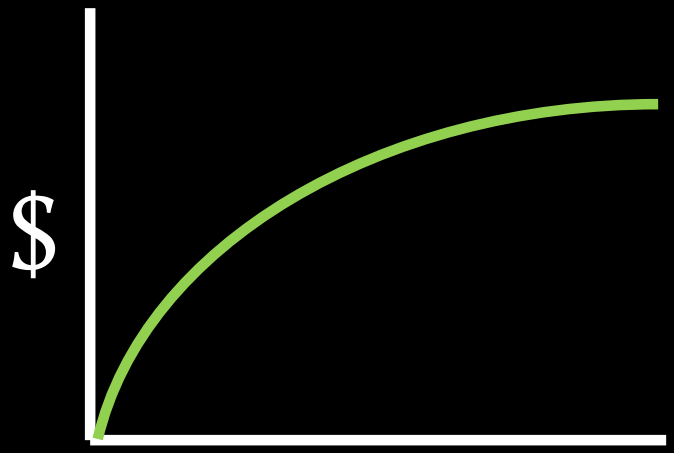


Total benefit

Marginal benefit

3. "Pollution services": costs and benefits

Now, there's also another way—besides this one—
of understanding the meaning
of a firm's demand for pollution services.



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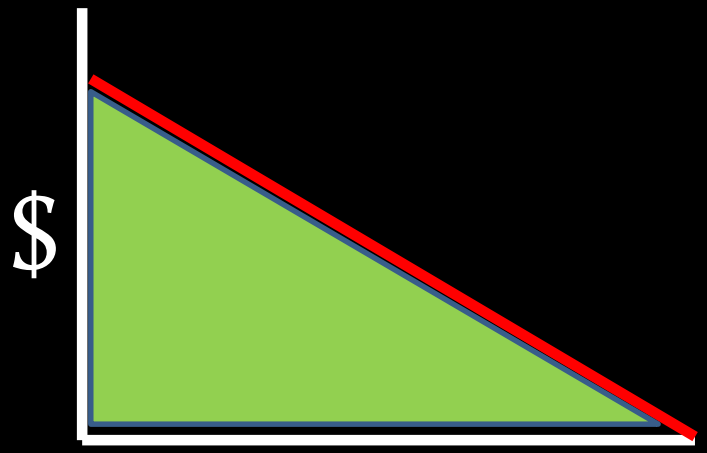
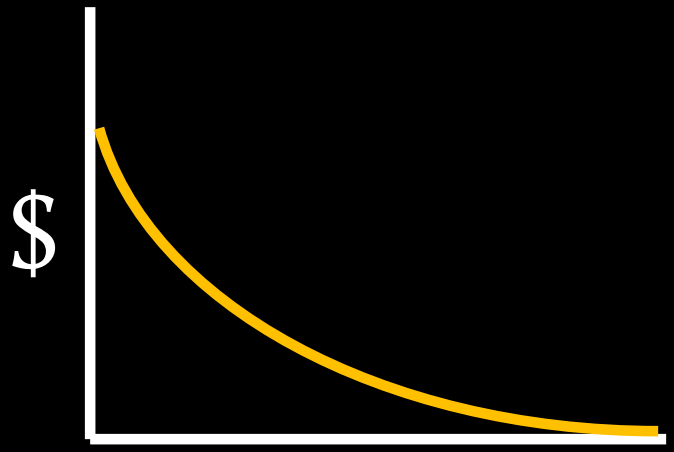
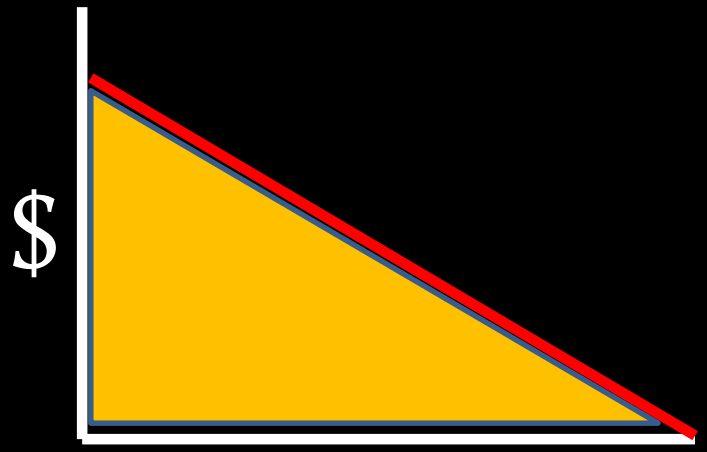


Demand for pollution services = marginal benefits from polluting

3. "Pollution services": costs and benefits

Alternately: the firm's demand for pollution services is a function of the marginal abatement costs that it **avoids** when the community lets it pollute more!





total abatement cost from BAU maximum

Demand for pollution services = marginal abatement cost avoided

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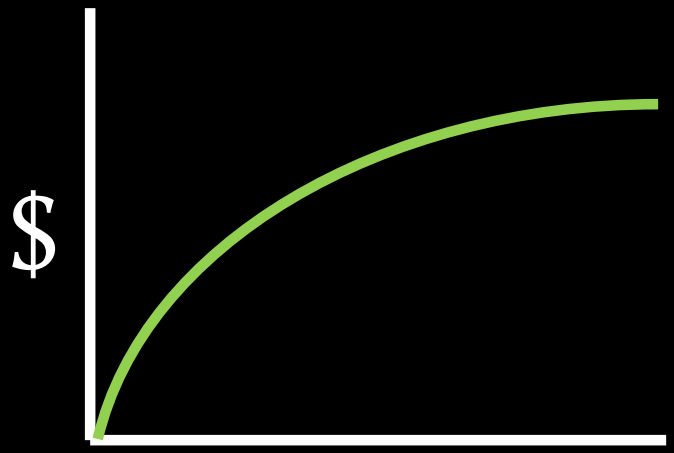

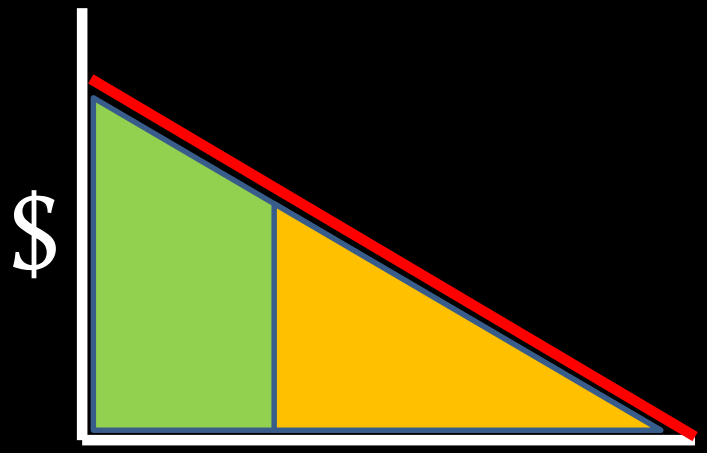

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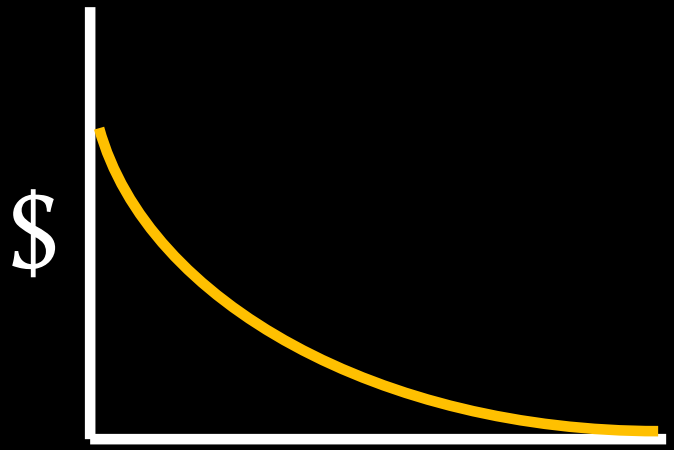

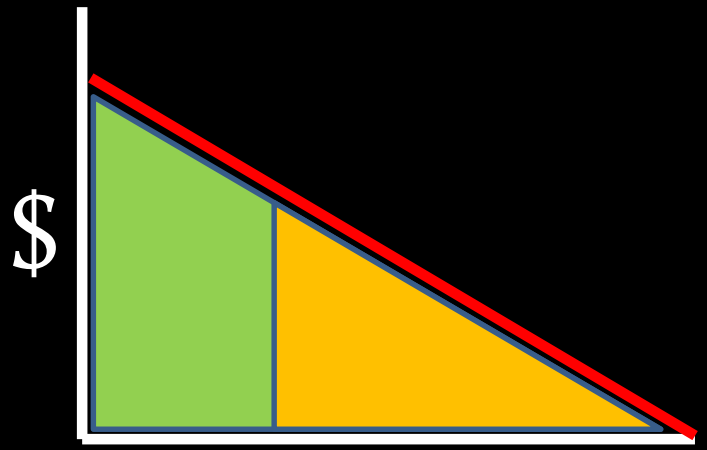

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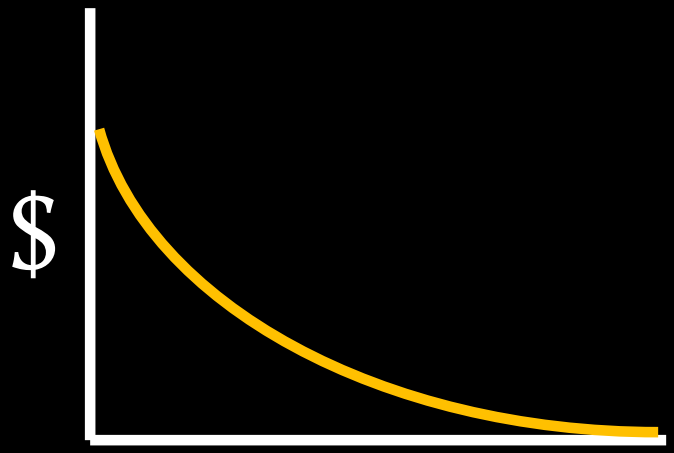
3. "Pollution services": costs and benefits

Hence a MAC (marginal abatement cost) curve is really a demand curve in disguise, reflecting the firm's demand for pollution services.



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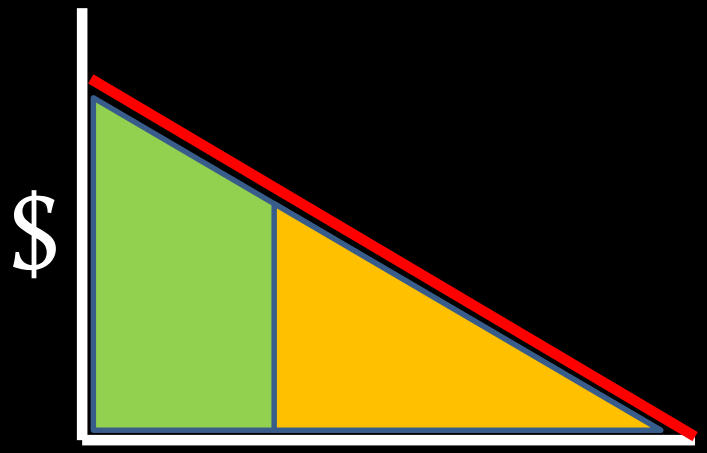
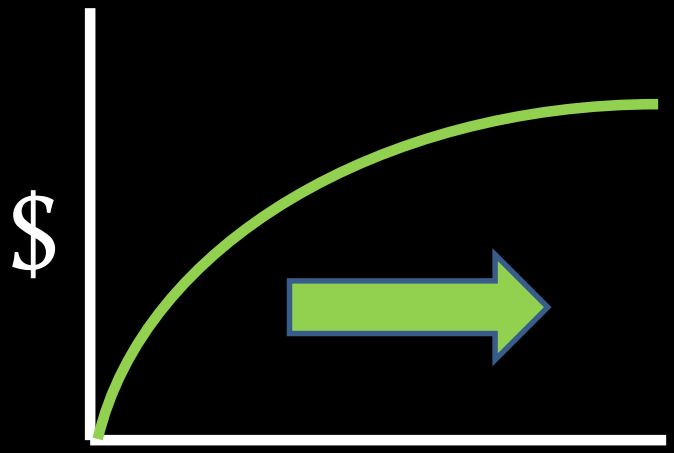


Demand for pollution services = marginal abatement cost avoided

3. "Pollution services": costs and benefits

Just remember! Unlike standard demand curves, MAC curves should be read **from right to left** (as they describe abatement from the maximum).



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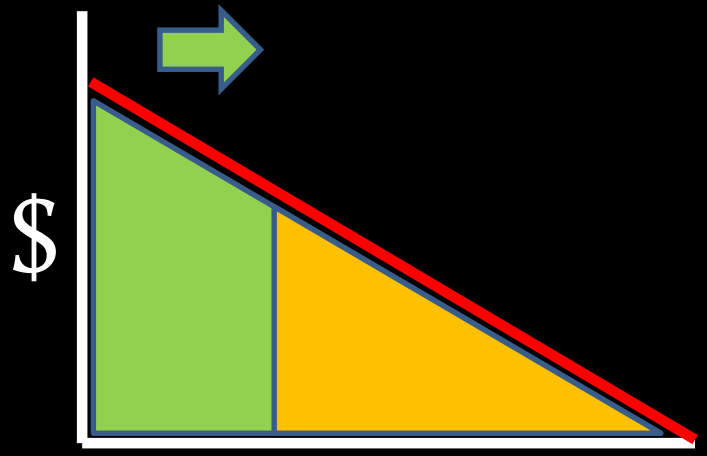

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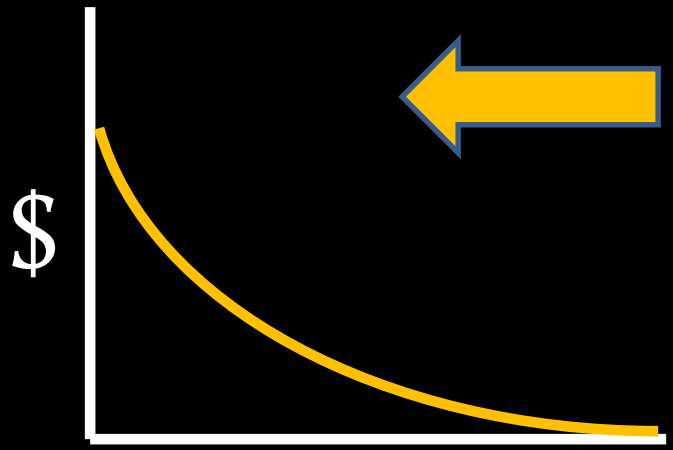

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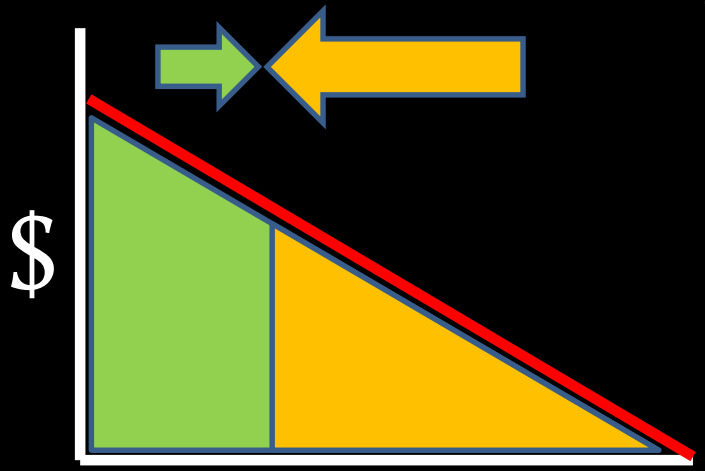

Demand for pollution services = marginal abatement cost avoided

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4. Working with MD and MAC curves

4.1. MD (marginal damage) curves

4.2. MAC (marginal abatement cost) curves

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4. Working with MD and MAC curves

4.1.1. MD functions

Two ways to measure marginal pollution damage:

4. Working with MD and MAC curves

4.1.1. MD functions

Two ways to measure marginal pollution damage:

Marginal emission damage curves show the damage caused by each new unit of a pollutant emitted.

Marginal ambient damage curves show the damage caused by each new unit increase in the ambient concentration of a pollutant.

4. Working with MD and MAC curves

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4. Working with MD and MAC curves

4.1.2. Typical features of MD curves

-
-
-

4. Working with MD and MAC curves

4.1.2. Typical features of MD curves

- At low emissions / ambient levels,
  marginal damages are small.
-
-

4. Working with MD and MAC curves

4.1.2. Typical features of MD curves

- At low emissions / ambient levels,
  marginal damages are small.
- There is commonly a threshold
  below which marginal damages are zero.
-

4. Working with MD and MAC curves

4.1.2. Typical features of MD curves

- At low emissions / ambient levels,
  marginal damages are small.
- There is commonly a threshold
  below which marginal damages are zero.
- MD curves typically have different slopes
  in urban vs. rural areas (which are higher?)
  and in areas with strong vs. weak winds
  (again, which would you guess are higher?)

4. Working with MD and MAC curves

4.1. MD (marginal damage) curves

4.2. MAC (marginal abatement cost) curves

4. Working with MD and MAC curves

4.2.1. MAC (marginal abatement cost) functions

Marginal abatement cost functions take account of the total cost of various methods of reducing emissions, chiefly:

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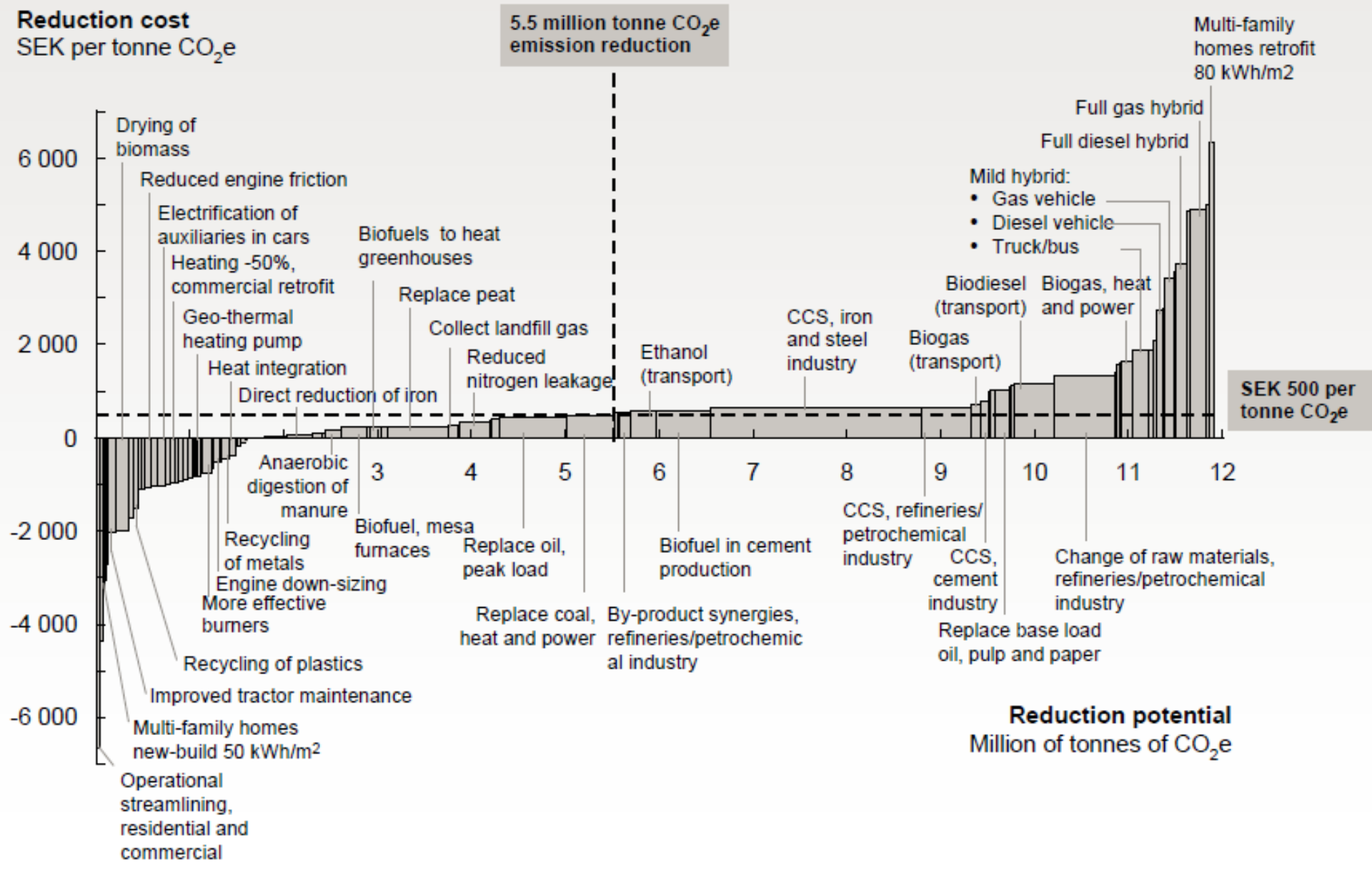
- input substitution (upstream)
- output recycling or treatment (downstream)
- changes in production technology (midstream)
- other foregone benefits (opportunity costs)

Measures in Sweden beyond the Reference scenario 2020



4. Working with MD and MAC curves

4.2.2. Typical features of MAC curves

Marginal abatement costs typically increase faster and faster as emissions are reduced (i.e., from right to left).

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- different firms' technological starting points
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Marginal abatement costs typically increase faster and faster as emissions are reduced (i.e., from right to left).

Why is this the case?

Different MAC curves can reflect

- different firms' technological starting points
- different stages in a single firm's technological development

Plan of this lecture

1. Cost-benefit analysis: quick recap
2. Rethinking supply and demand
3. “Pollution services”: costs and benefits
4. Working with MD and MAC curves
5. How to aggregate (add) MAC curves
6. Preview (if time):
   the equimarginal principle

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To aggregate multiple MAC curves,
add them **horizontally**:

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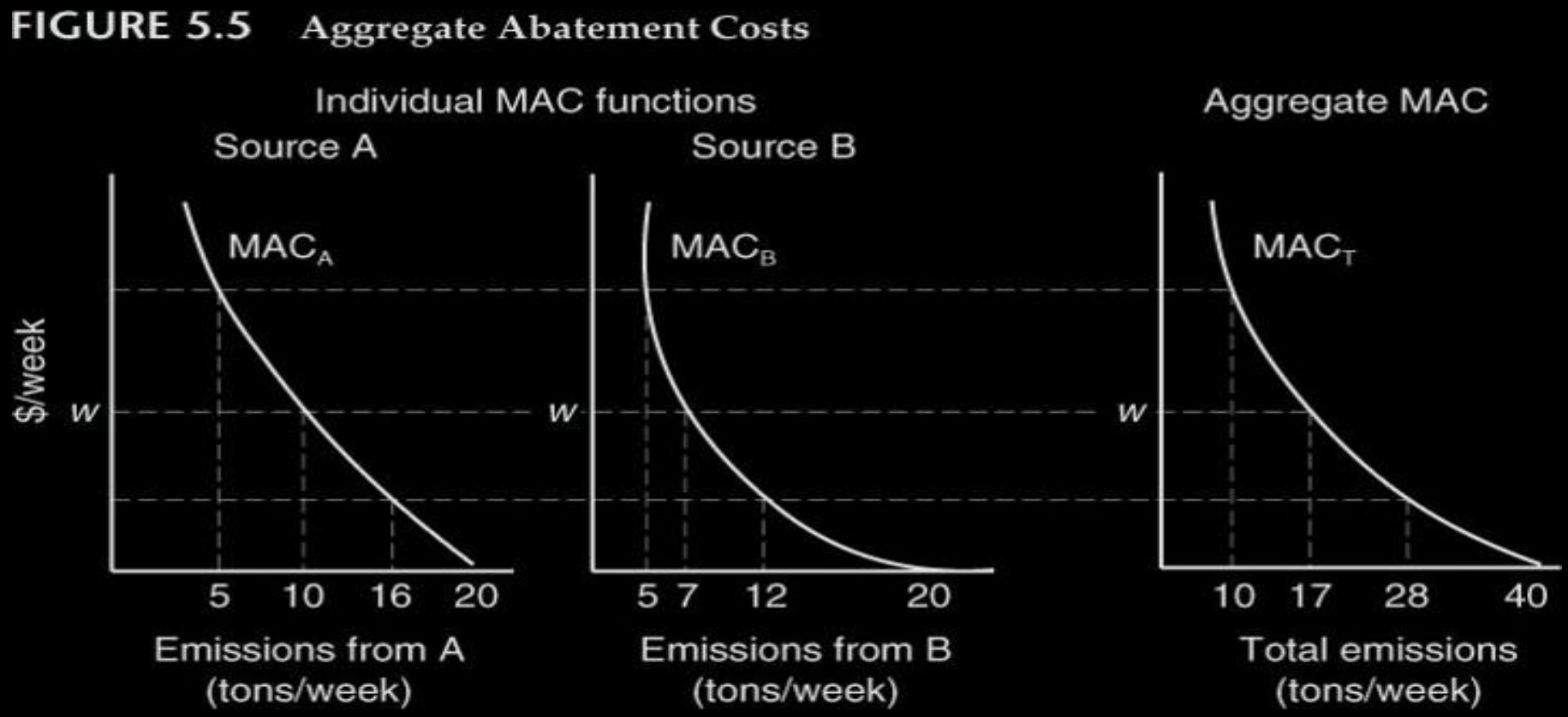
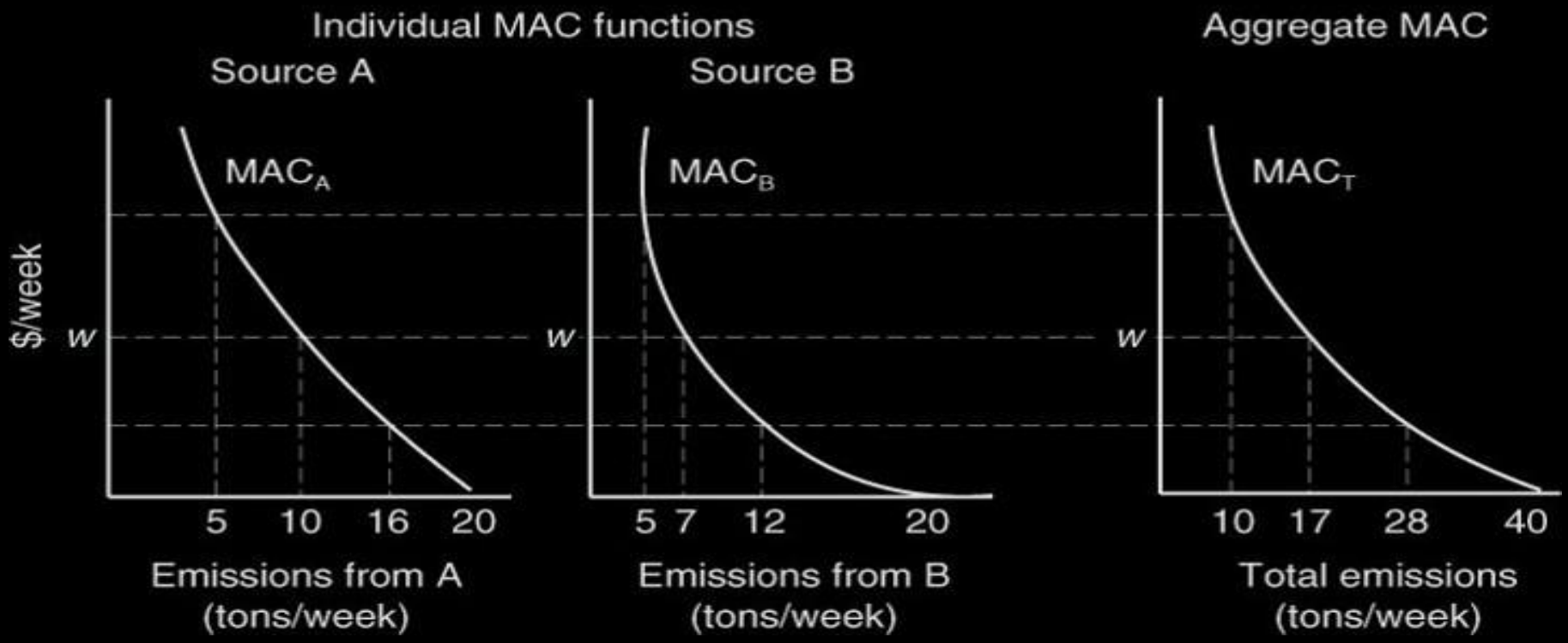


5. How to aggregate (add) MAC curves

To aggregate multiple MAC curves,

add them **horizontally**: ⟸ Why not vertically?

FIGURE 5.5 Aggregate Abatement Costs



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"To get the **minimum** aggregate MAC curve,
the aggregate level of emissions must be distributed
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that they all have the same marginal abatement costs."

(Field, p. 100)

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