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# **Unit 1**

## Basic Concepts in Benefit-Cost Analysis (BCA)

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## Objectives

At the end of this unit, participants will be able to:

- Describe the basic terms used in Benefit-Cost Analysis (BCA).
- Explain how to determine when to do a BCA and when it will be cost effective.

## Scope

- Welcome and Introductions
- Classroom Ground Rules and Processes
- Unit 1 Overview & Objectives
- What is Benefit-Cost Analysis?
- Benefits and Costs
- How do we know if something is “worth it”? (Cost Effectiveness)
- Applications of BCA
- Discount rate
- Net present value
- Unit 1 Review

## Methodology

This training course will be delivered as an in-person classroom course, and will use a combination of lecture, discussion, and individual/group work on the computer.

The instructor(s) will start the session with a welcome message, followed by introductions. The host (either the EMI course manager or the field coordinator) will explain the classroom ground rules and processes. The instructor will then go through each slide, pausing for questions and short discussion if needed. The instructor should also prompt students to follow along in their Student Manuals, which may be viewed electronically.

## Time Plan

A suggested time plan for each topic in this unit is shown below. More or less time may be required, based on the experience level of the group.

- Welcome and Introductions (10 minutes)
- Classroom Ground Rules and Processes (10 minutes)
- Unit 1 Overview and Objectives (5 minutes)
- What is Benefit-Cost Analysis? (10 minutes)
- Benefits and Costs (10 minutes)
- How do we know if something is “worth it”? (Cost Effectiveness) (10 minutes)
- Applications of BCA (3 minutes)
- Why should I do a BCA? (2 minutes)
- Discount rate (10 minutes)
- Net present value (10 minutes)
- Unit 1 Review (5 minutes)

**Total Time (Estimated): 1 hour 25 min**

## Materials

- Unit 1 Visuals
- Unit 1 Instructor Guide
- Unit 1 Student Manual (electronic)
- Whiteboard or easel paper, markers (if available)

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**Welcome and Introductions**

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## Unit 1: Basic Concepts in Benefit-Cost Analysis (BCA)

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*Visual 1: Unit 1 - Basic Concepts in Benefit-Cost Analysis (BCA)*

**Instructor:**

Welcome to the Introduction to Benefit-Cost Analysis (BCA) course! This course is intended to familiarize you with the concepts behind BCA and teach you how to complete BCAs for a variety of hazard mitigation project types.

*Introduce yourself and then ask the host to introduce him/herself, if applicable. Feel free to describe briefly your background with FEMA, hazard mitigation, and/or BCAs.*



*Once you and the host have introduced yourselves, ask each participant to give their name, organization, geographical location, background, experience and reason for attending the course.*

**Instructor:**

We will begin the course with Unit 1 of the Introduction to Benefit-Cost Analysis (BCA) course. This unit focuses on basic concepts in BCA.

Please follow along with the presentation in your Student Manual, which you can view on your computer. It is available for download at [www.fema.gov/benefit-cost-analysis](http://www.fema.gov/benefit-cost-analysis).

If you printed the Student Manual, you may want to take notes on each page.

**Unit 1 Overview**

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## Unit 1 Overview

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- Introduce students to the basic concepts behind Benefit-Cost Analysis (BCA).
- Introduce students to the role of the BCA in Hazard Mitigation Assistance (HMA) grants.
- Introduce students to the basic terms used when discussing BCA.

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*Visual 2: Unit 1 Overview*

**Instructor:**

In this unit we will cover several topics:

- We will discuss the basic concepts behind Benefit-Cost Analysis (BCA).
- We will introduce students to the role of the BCA in Hazard Mitigation Assistance (HMA) grants.
- We will also talk about the basic terms used when discussing BCA.

**Unit 1 Objectives**

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## Unit 1 Objectives

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- Students should be able to describe the basic terms used in Benefit-Cost Analysis (BCA).
- Students should be able to explain how to determine when to do a BCA and when it will be cost effective.

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*Visual 3: Unit 1 Objectives*

**Instructor:**

The purpose of this unit is for students to become familiar with the basic concepts behind Benefit-Cost Analysis (BCA). At the end of this unit, you should be able to:

- Describe the basic terms used in Benefit-Cost Analysis (BCA).
- Explain how to determine when to do a BCA and when it will be cost effective.

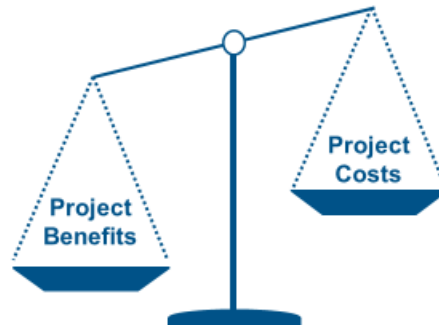
## What is Benefit-Cost Analysis (BCA)?

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### What is Benefit-Cost Analysis (BCA)?

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- **Benefit-Cost Analysis (BCA)** is the process of quantifying the advantages (benefits) of an action and comparing it to its drawbacks (costs).



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*Visual 4: What is Benefit-Cost Analysis (BCA)?*

#### **Instructor:**

Benefit-Cost Analysis (BCA) is the process of quantifying the advantages of an action (what we call benefits) to its drawbacks (what we call costs).

We'll discuss BCA in relation to hazard mitigation projects more in Unit 3. For now, we'll focus on learning the basic concepts behind BCA.

## What is Benefit-Cost Analysis (BCA)?

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### What is Benefit-Cost Analysis (BCA)? (cont.)

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Although BCA may seem like a difficult concept, you probably already practice it almost every day.

- Examples:
  - Is a warehouse club membership worth it?
  - Should I fix that leaky toilet in my house?
  - Should I buy or rent a house?
- What factors go into your decision?

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*Visual 5: What is Benefit-Cost Analysis (BCA)? (cont.)*

#### **Instructor:**

Although BCA may seem like a difficult concept, you probably already practice it in your everyday life.

For example, have you ever considered questions like the following?

- Is a warehouse club membership worth it?
- Should I fix that leaky toilet in my house?
- Should I buy or rent a house?



*Ask students to volunteer other examples where they practice BCA in real life. You may write them on a whiteboard/easel paper if available.*



**Benefits and costs**

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## Benefits and costs

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We'll discuss benefits and costs in relation to hazard mitigation projects more in Unit 3, but for now let's consider the example of the leaky toilet.

- What are the **benefits** of replacing it? How would I quantify these benefits?
- What are the **costs** of replacing it?

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*Visual 6: Benefits and costs*

**Instructor:**

We will discuss benefits and costs specific to hazard mitigation projects more in Unit 3. For now, let's consider the example of the leaky toilet.

What are some benefits of replacing it?



*Ask students to offer ideas. You may write them down on a whiteboard or easel paper, if available.*

What are the costs of replacing it?



*Ask students to offer ideas. You may write them down on a whiteboard or easel paper, if available.*

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**Benefits and costs**

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## Benefits and costs (cont.)

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- Benefits:
    - Lower water bills
    - Reduced damage to floor
    - Less worry about damage?
    - Reduced time spent fixing leak or cleaning up mess?
  - Costs:
    - Cost of new toilet + materials
    - Pay someone to install toilet
    - Take time off work to supervise installation of toilet
    - Maintenance?
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*Visual 7: Benefits and costs (cont.)*

**Instructor:**

For this particular project, replacing the toilet, some benefits may include lower water bills, reduced damage to the bathroom floor, less worry about damage, and reduced time spent fixing leaks or cleaning up the mess.



Ask students the following:

- Can we quantify all these benefits?
  - Lower water bills: Yes. *Discuss how the lower water bills would be quantified by comparing your current water bill to your expected water bill. The difference between the two would be the benefit.*
  - Reduced damage to floor: Yes. *Discuss how reduced damage to floor would be quantified by estimating how much it would cost to repair the floor if the toilet is not replaced.*
  - Less worry about damage: No. *Mention that subjective qualities are not able to be counted as benefits for BCA.*
  - Reduced time spent fixing leak or cleaning up mess: Yes. *We can compare the time spent on these activities before replacing the toilet to after.*
  - *You may also want to discuss the benefits contributed by the students on the last slide, and whether or not these are quantifiable, and why or why not.*
- If something cannot be quantified, should we include them in our BCA?

- *Answer: No.*

For this particular project, some costs may include:

- The cost of the new toilet plus any materials
- The cost to pay someone to install the toilet
- Time taken away from other activities to supervise installation or do it yourself
- Potential maintenance costs with new toilet

How do we know if something is worth the investment?

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## How do we know if something is “worth it”? (1 of 3)

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- If an action’s benefits are greater than its costs, then it is considered **cost-effective**.
- Once we add up the benefits for an action, we divide that value by the costs, which gives us the **Benefit-Cost Ratio (BCR)**.

$$\frac{\text{Benefits}}{\text{Costs}} = \text{BCR}$$

***If the BCR is greater than or equal to 1.0, then the action is cost-effective.***

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*Visual 8: How do we know if something is “worth it”? (1 of 3)*

### **Instructor:**

If an action’s benefits are greater than its costs, then it is considered to be cost-effective.

Once we add up the benefits of an action, we divide that value by the costs. This gives us the Benefit-Cost Ratio (BCR).



*Review the following equation with the students:*

$$\frac{\text{Benefits}}{\text{Costs}} = \text{BCR}$$

If the BCR is greater than 1.0, then the action is considered cost-effective.

How do we know if something is worth the investment?

## How do we know if something is “worth it”? (2 of 3)

• Is it worth \$1 million to:

1. Protect one vacation home?
2. Protect one government building that floods infrequently?
3. Protect a flood-prone hospital or wastewater treatment plant?
4. Protect 150 flood-prone houses?

	Probably	Probably Not
1. Protect one vacation home?		
2. Protect one government building that floods infrequently?		
3. Protect a flood-prone hospital or wastewater treatment plant?		
4. Protect 150 flood-prone houses?		

Visual 9: How do we know if something is “worth it”? (2 of 3)



Ask students the following and have them write their answers in their Student Manuals. Give them a few minutes to think about their answers.

- Do you think it is worth \$1 million to protect these structures from flooding? Why or why not?

How do we know if something is worth the investment?

## How do we know if something is “worth it”? (3 of 3)

• Is it worth \$1 million to:

1. Protect one vacation home?
2. Protect one government building that floods infrequently?
3. Protect a flood-prone hospital or wastewater treatment plant?
4. Protect 150 flood-prone houses?

	Probably	Probably Not
1. Protect one vacation home?		<input checked="" type="checkbox"/>
2. Protect one government building that floods infrequently?		<input checked="" type="checkbox"/>
3. Protect a flood-prone hospital or wastewater treatment plant?	<input checked="" type="checkbox"/>	
4. Protect 150 flood-prone houses?	<input checked="" type="checkbox"/>	

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*Visual 10: How do we know if something is “worth it”? (3 of 3)*

### **Instructor:**

Intuitively, we know that a million-dollar mitigation project to protect a one vacation home or a building that doesn't flood frequently is probably not a good investment.

On the other hand, a million-dollar mitigation project to protect a large number of flood-prone houses or important buildings is probably a worthwhile investment.

Cost is always a key determinant of cost-effectiveness. Protecting a hospital may be cost-effective at \$500,000 but not if the mitigation project costs \$5,000,000.



*Ask students the following and give them a few minutes to think about their answers.*

- Why are the last two projects worth doing, while the first two are not?

## Applications of BCA

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### Applications of BCA

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- BCA can be used to determine if a single action is cost-effective in comparison to the status quo:
  - Should I replace that leaky toilet, or leave it as-is?
- Or it can be used to determine the most cost-effective option out of several:
  - Should I (1) replace the leaky toilet, (2) try to repair it, or (3) remodel my entire bathroom?
- For hazard mitigation projects, we are usually doing the first way, since we do not require applicants to show that they are choosing the most cost-effective option.

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#### *Visual 11: Applications of BCA*

#### **Instructor:**

BCA can be used multiple ways. For one, it can be used to determine if a single action is cost-effective in comparison to the status quo:

- For example: Should I replace that leaky toilet, or leave it as-is?

Or, it can be used to determine the most cost-effective option out of several.

- For example: Should I (1) replace the leaky toilet, (2) try to repair it, or (3) remodel my entire bathroom?
- It is important to note that the last option, remodeling the bathroom, could very well be cost-effective when compared to the status quo. But it is unlikely to be the **most** cost-effective option.

For hazard mitigation projects, we are usually doing the first way, since we do not require applicants to show that they are choosing the **most** cost-effective option.

Remember that the BCA is only one component subapplicants must consider when determining which project is their preferred option. The other components are discussed briefly in Unit 3 and in more detail in E0212.

## Why should I do a BCA?

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### Why should I do a BCA?

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- Required component for HMA projects
- Required for some 406 (Public Assistance) mitigation projects
- Helps communities and subapplicants make informed decisions about their risks and money and prioritize projects

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*Visual 12: Why should I do a BCA?*

**Instructor:**

There are several reasons you should do a BCA. They include:

- A BCA is a required component of most HMA project applications
- A BCA is required for some 406 (Public Assistance) mitigation projects
- BCAs help communities and subapplicants make informed decisions about their risks and money and prioritize projects

We'll discuss the statutory and regulatory requirement for BCA in the next unit.

For those of you who've taken the 212 course, HMA: Developing Quality Application Elements, you should know why you need to conduct a Benefit-Cost Analysis. For those who haven't taken the 212 course, it's important to know that a Benefit-Cost Analysis is a required component of a complete Hazard Mitigation Assistance project subapplication.



**Other common BCA terms**

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## Other common BCA terms

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- Discount rate
- Net present value

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*Visual 13: Other common BCA terms*

**Instructor:**

Now let's discuss a couple of other terms commonly used in BCA:

- Discount rate
- Net present value

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**Discount rate**

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## Discount rate

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- If I offered you \$100 today, or \$100 one year from now, which would you choose? Why?
  - \$100 invested today might result in \$106 one year from now.
  - \$100 one year from now might only buy \$97 worth of goods.
- Because benefits are worth more if they are experienced sooner, future benefits must be discounted. The rate at which benefits decline in value each year is the **discount rate**.
  - Federally-funded mitigation projects must use a discount rate of 7%, which is set by the U.S. Office of Management and Budget (OMB). We'll discuss this more in Unit 3.

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*Visual 14: Discount rate***Instructor:**

If I offered you \$100 today, or \$100 one year from now, which would you choose? Why?

You'd probably choose to have \$100 today because:

- \$100 invested today might result in \$106 one year from now.
- \$100 one year from now might only buy \$97 worth of goods.

Because benefits are worth more if they are experienced sooner, future benefits must be discounted. The rate at which benefits decline in value each year is the discount rate.

Federally-funded mitigation projects must use a discount rate of 7%, which is set by the U.S. Office of Management and Budget (OMB). We'll discuss this more in Unit 3.



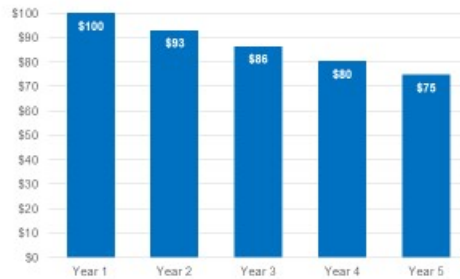
*Ask students the following and discuss briefly.*

- How do you think using a higher or lower discount rate for a mitigation project would affect the BCR?

## Discount rate

## Discount rate (cont.)

- Example: Let's say I have a mitigation project with \$100 in benefits in Year 1. With a discount rate of 7%, my annual benefits would be as follows:



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*Visual 15: Discount rate (cont.)*

**Instructor:**

Let's say I have a mitigation project with \$100 in benefits in Year 1. With a discount rate of 7%, my annual benefits would be as follows:

	Annual benefits
Year 1	\$100
Year 2	\$93
Year 3	\$86
Year 4	\$80
Year 5	\$75

As you can see, the benefits are reduced by 7% each year.

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**Net present value**

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## Net present value, 1 of 6

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- **Net present value (NPV)** is the value today of benefits that you will receive in the future, minus the value today of costs that you will incur in the future.
- A positive NPV indicates that something is a good investment.

$$\begin{array}{r} \text{Future benefits} \\ \text{(in today's} \\ \text{dollars)} \end{array} - \begin{array}{r} \text{Costs} \\ \text{(in today's} \\ \text{dollars)} \end{array} = \begin{array}{r} \text{Net Present} \\ \text{Value (NPV)} \end{array}$$

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*Visual 16: Net Present Value, 1 of 6*

**Instructor:**

Net present value (NPV) is the value today of benefits that you will receive in the future, minus the value today of costs that you will incur in the future.



*Review the following equation with the students:*

$$\text{Future benefits (in today's dollars)} - \text{Costs (in today's dollars)} = \text{Net Present Value (NPV)}$$

A positive NPV indicates that something is a good investment.

**Net present value**

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## Net present value, 2 of 6

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- Example: Let's say I would like to rent out my basement. In order to make the space rentable, I will have to spend \$25,000 to renovate it and get a certificate of occupancy. The basement will rent for \$1,000 per month, and I plan to rent it out over a period of 3 years.
- Is this a good investment? How can I figure this out?

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*Visual 17: Net present value, 2 of 6*

**Instructor:**

Let's say I would like to rent out my basement. In order to make the space rentable, I will have to spend \$25,000 to renovate it and get a certificate of occupancy. The basement will rent for \$1,000 per month, and I plan to rent it out over a period of 3 years.



*Ask students:* Is this a good investment? How can I figure this out?

*Note:* This is a very simplified example and does not take inflation, rent increases, etc. into account.

Net present value

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## Net present value, 3 of 6

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$$\text{Future benefits (in today's dollars)} - \text{Costs (in today's dollars)} = \text{Net Present Value (NPV)}$$

- In Year 1, my benefits from renting out my basement are \$1,000 x 12 = \$12,000.
- What are my benefits in Year 2 if I assume a 7% discount rate? (Hint: The answer is not \$12,000.)

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*Visual 18: Net present value, 3 of 6*

**Instructor:**

First, let's figure out the first part of our equation: future benefits in today's dollars.

We calculate this by using the discount rate.

In Year 1, my benefits from owning the rental property are \$1,000 x 12 = \$12,000.



*Ask students:* What are my benefits in Year 2? (Hint: It's not \$12,000.)

## Net present value

## Net present value, 4 of 6

$$\text{Future benefits (in today's dollars)} - \text{Costs (in today's dollars)} = \text{Net Present Value (NPV)}$$

Benefits are reduced by 7% each year over the 3-year period:



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Visual 19: Net present value, 4 of 6

**Instructor:**

Recall we have a discount rate of 7%.

Since my benefits are reduced by 7% each year, my total benefits over the 3-year period are:

	Annual benefits
Year 1	\$12,000
Year 2	\$11,520
Year 3	\$11,059
<b>Sum:</b>	<b>\$33,539</b>

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**Net present value**

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## Net present value, 5 of 6

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$$\begin{array}{r} \text{Future benefits} \\ \text{(in today's} \\ \text{dollars)} \end{array} - \begin{array}{c} \text{Costs} \\ \text{(in today's} \\ \text{dollars)} \end{array} = \begin{array}{r} \text{Net Present} \\ \text{Value (NPV)} \end{array}$$

- In this very simplified example, my costs are my original investment:

\$25,000

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*Visual 20: Net present value, 5 of 6*

**Instructor:**

Now that we have calculated the value of our future benefits in today's dollars (\$33,539), let's determine the costs.

In this very simplified example, the costs are my original investment of \$25,000.



Net present value

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## Net present value, 6 of 6

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$$\begin{array}{r} \text{Future benefits} \\ \text{(in today's} \\ \text{dollars)} \end{array} - \begin{array}{r} \text{Costs} \\ \text{(in today's} \\ \text{dollars)} \end{array} = \text{Net Present} \\ \text{Value (NPV)}$$

- For this example:

$$\$33,539 - \$25,000 = \$8,539$$

- Did I make a good investment?

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*Visual 21: Net present value, 6 of 6*

**Instructor:**

My Net Present Value (NPV) is \$8,539, which is a positive number.

$$\$33,539 - \$25,000 = \$8,539$$



*Ask students to discuss whether or not this was a good investment.*

Unit 1 Review

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## Unit 1 Review

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- Key terms:
  - Benefit-Cost Analysis (BCA)
  - Benefit
  - Cost
  - Benefit-Cost Ratio (BCR)
  - Cost-effectiveness
  - Discount rate
  - Net present value (NPV)

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*Visual 22: Unit 1 Review*

**Instructor:**

Let's review the concepts and terms we've discussed in this unit:



*Ask students to offer definitions for each term. Write them down on a whiteboard or easel paper if applicable.*

- Benefit-Cost Analysis (BCA)
- Cost
- Benefit-Cost Ratio (BCR)
- Cost-effectiveness
- Discount rate
- Net present value (NPV)