Quantum Computing Applications in Power Systems

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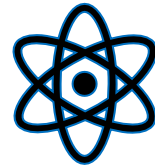S. Bahramirad
ComEd
USA

Introduction & Overview

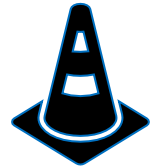**Introduction to Quantum Computing**

Quantum Computing vs. Classical Computing

Potential Applications of Quantum Computing

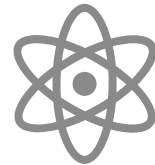**Potential Applications of Quantum Computing – Power Systems**

Conclusion

Introduction to Quantum Computing

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Introduction to Quantum Computing

Quantum Computing

Quantum computing is essentially harnessing and exploiting the laws of quantum mechanics to process information.

Classical Computer & Quantum Computer

A classical computer uses long strings of "bits", which encode either a zero or a one.

A quantum computer uses quantum bits, or qubits.

What's the difference?

A qubit is a quantum system that encodes the zero and the one into two distinguishable quantum states.

Qubits behave quantumly: "superposition" "entanglement"

Quantum Computer vs. Classical Computer

Introduction to Quantum Computing

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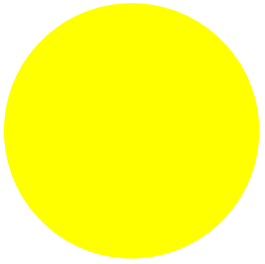**Potential Applications of Quantum Computing**

Potential Applications of Quantum Computing – Power Systems
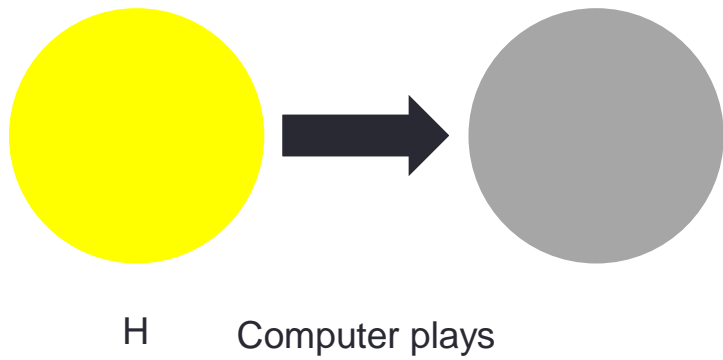
Conclusion

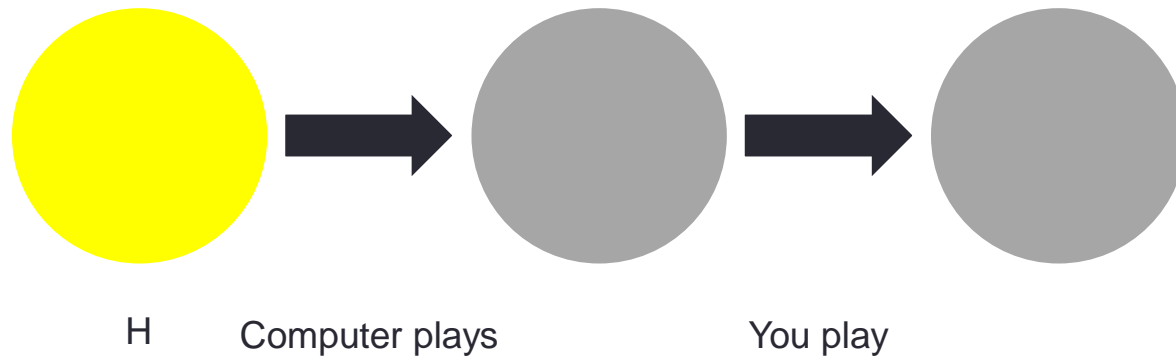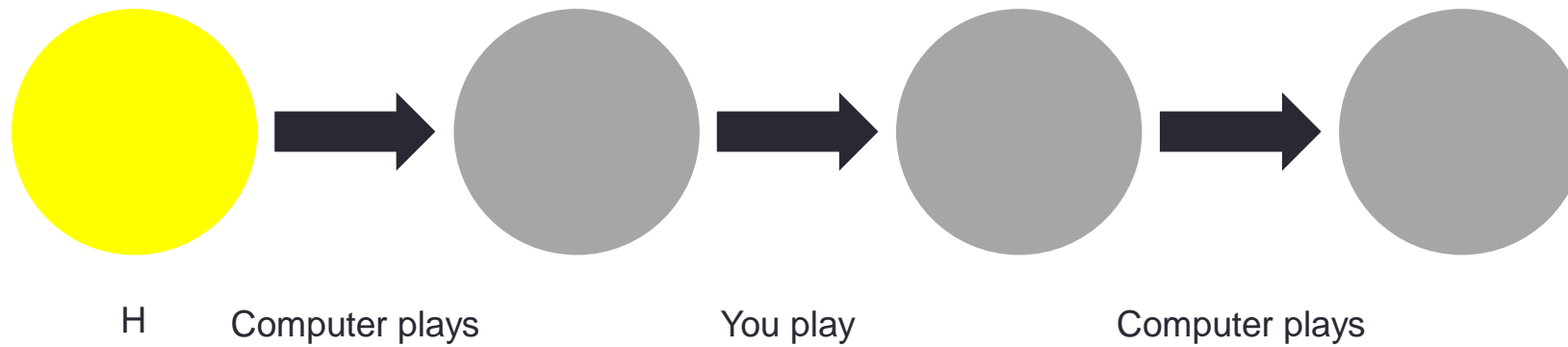# Coin Flipping Experiment with Classical Computer

H

Source: IBM

Coin Flipping Experiment with Classical Computer

H   Computer plays

Coin Flipping Experiment with Classical Computer

H   Computer plays   You play

Coin Flipping Experiment with Classical Computer

H   Computer plays   You play   Computer plays

Coin Flipping Experiment with Classical Computer

H

Computer plays

You play

Computer plays

H
Computer wins

T
You win

Coin Flipping Experiment with Classical Computer

Player wins
47%

Computer wins
53%

Quantum Computer

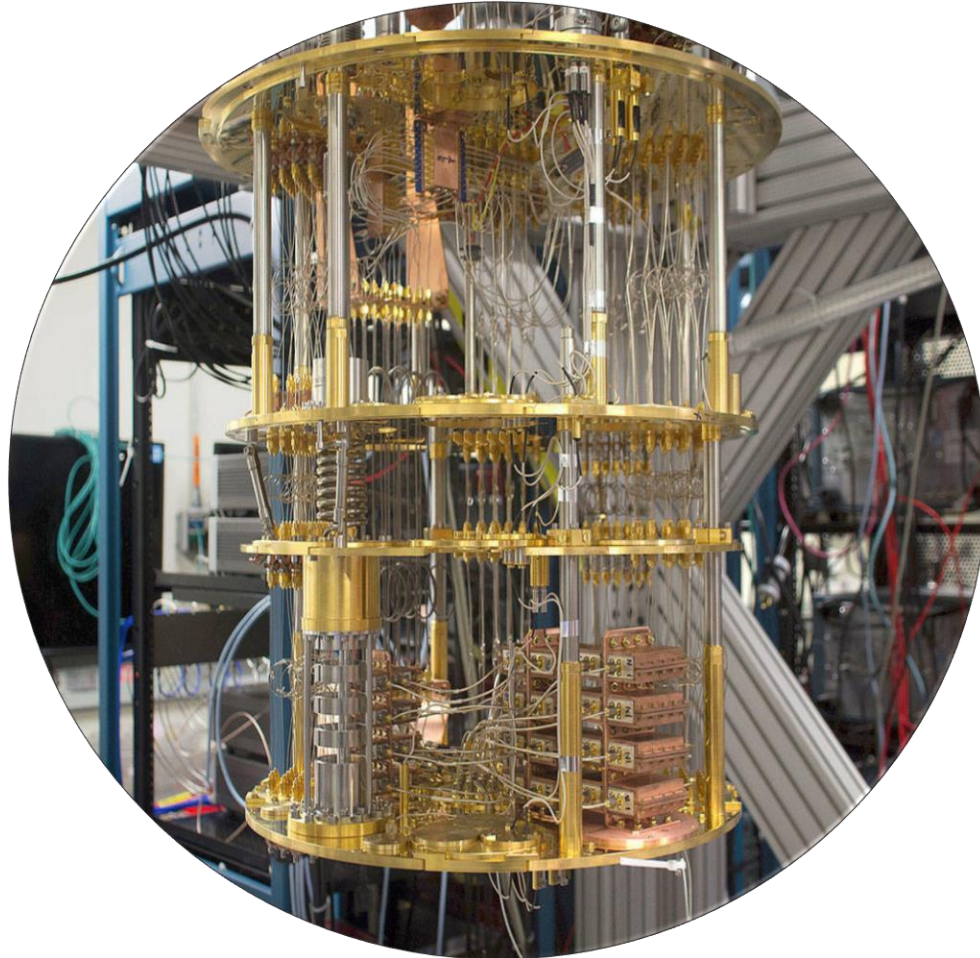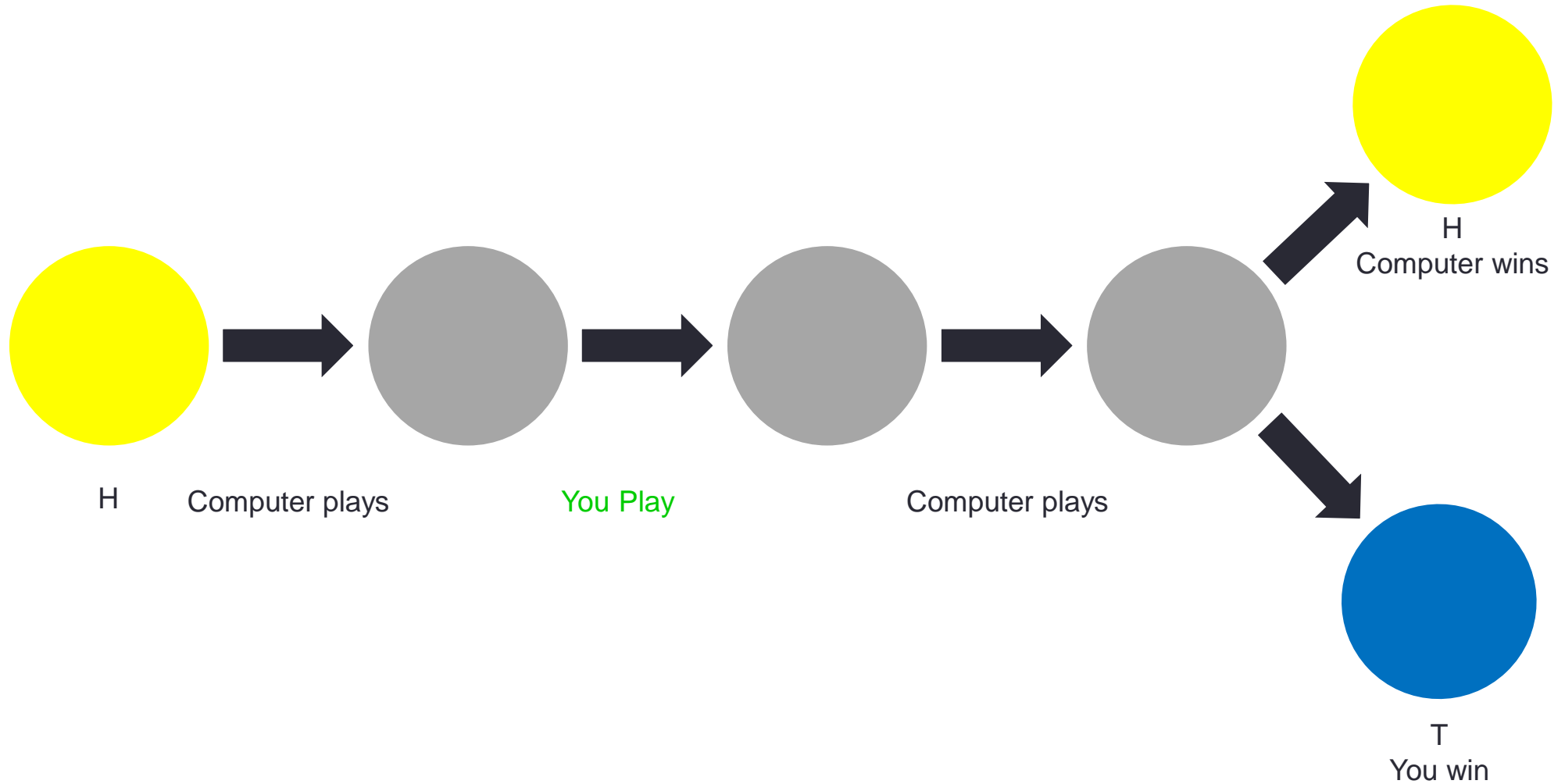
Image: University of Chicago

Quantum Computer vs. Classical Computer
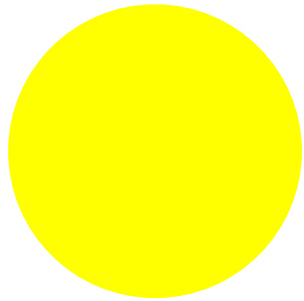

Images: Upsplash, Schmidt, Bianchi

Coin Flipping Experiment with Quantum Computer
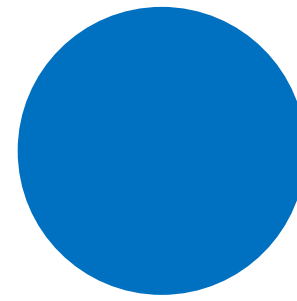

H   Computer plays   You Play   Computer plays

H
Computer wins

T
You win

How Did it Achieve This Amazing Winning Streak?

Player wins
3%

Quantum
Computer wins
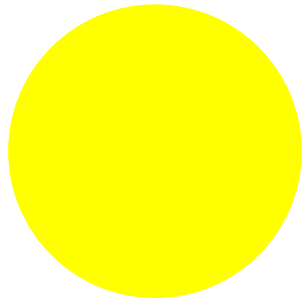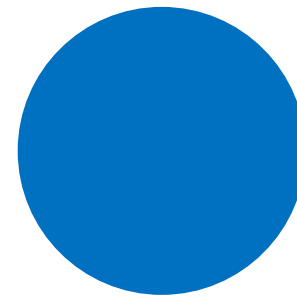97%
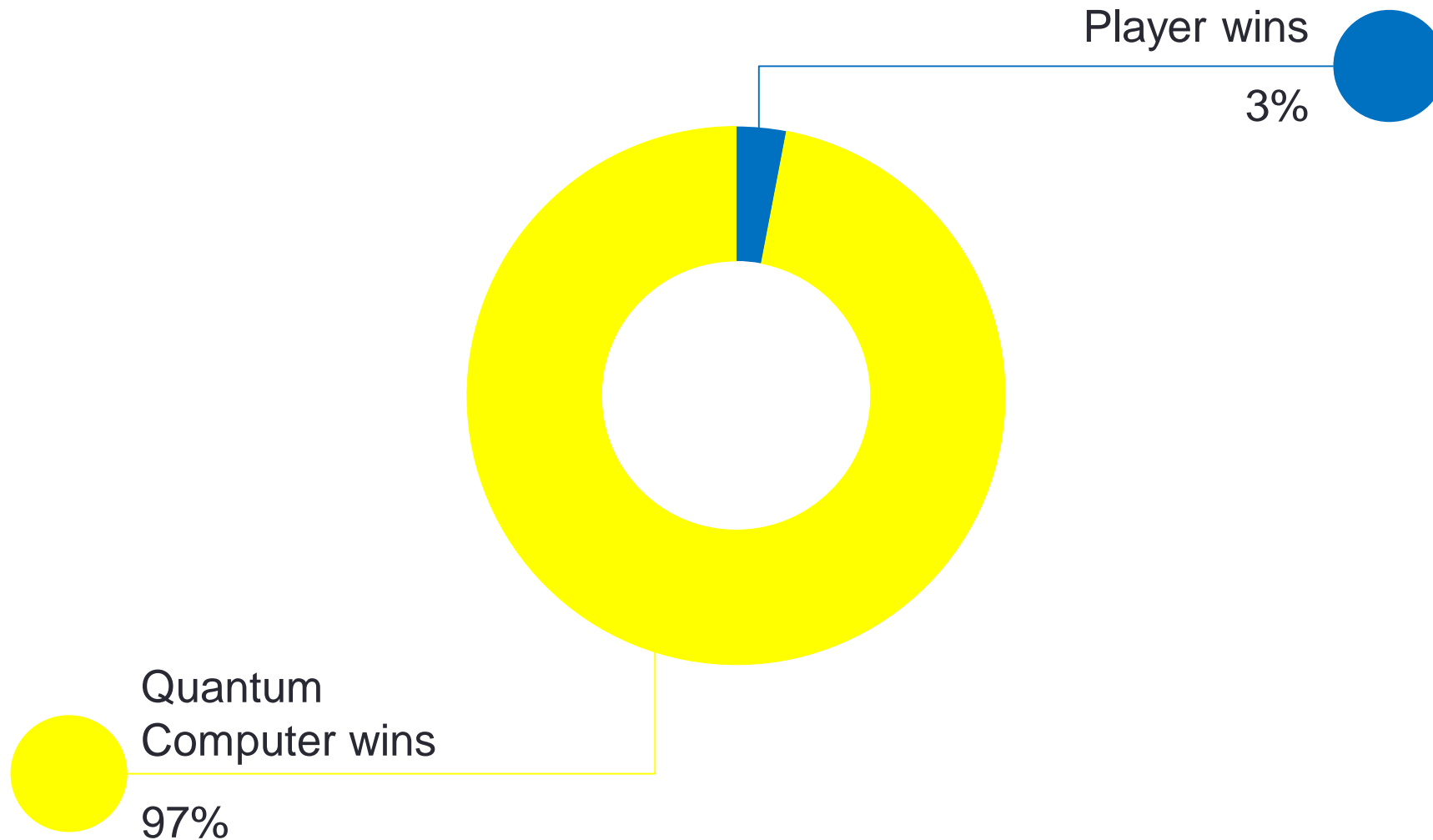
Coin Flipping Experiment with Quantum Computer

H

T

Coin Flipping Experiment with Quantum Computer

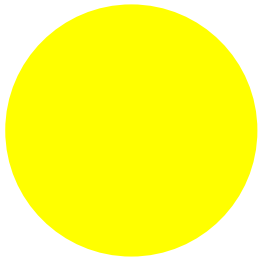# Coin Flipping Experiment with Quantum Computer

Superposition properties are expressed by quantum particles

H

T

0

1

H

H   Computer
         plays

H   Computer   You
           plays   play

Coin Flipping Experiment with Quantum Computer

H   Computer   You   Computer
      plays   play   plays

H

Computer
plays

You
play

Computer
plays

H
Computer wins

T
You win
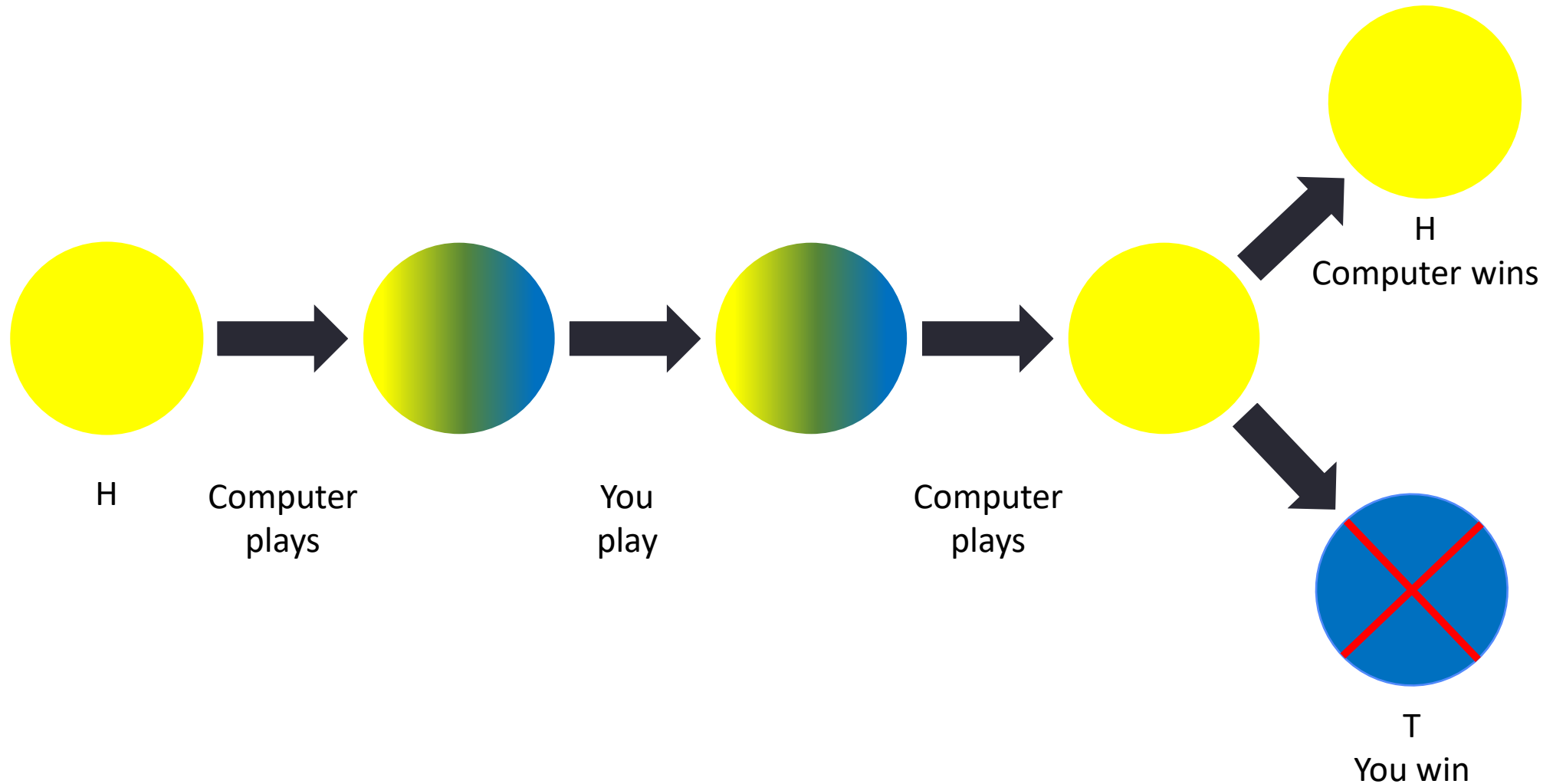
Coin Flipping Experiment with Quantum Computer

Player wins
3%

Quantum
Computer wins
97%
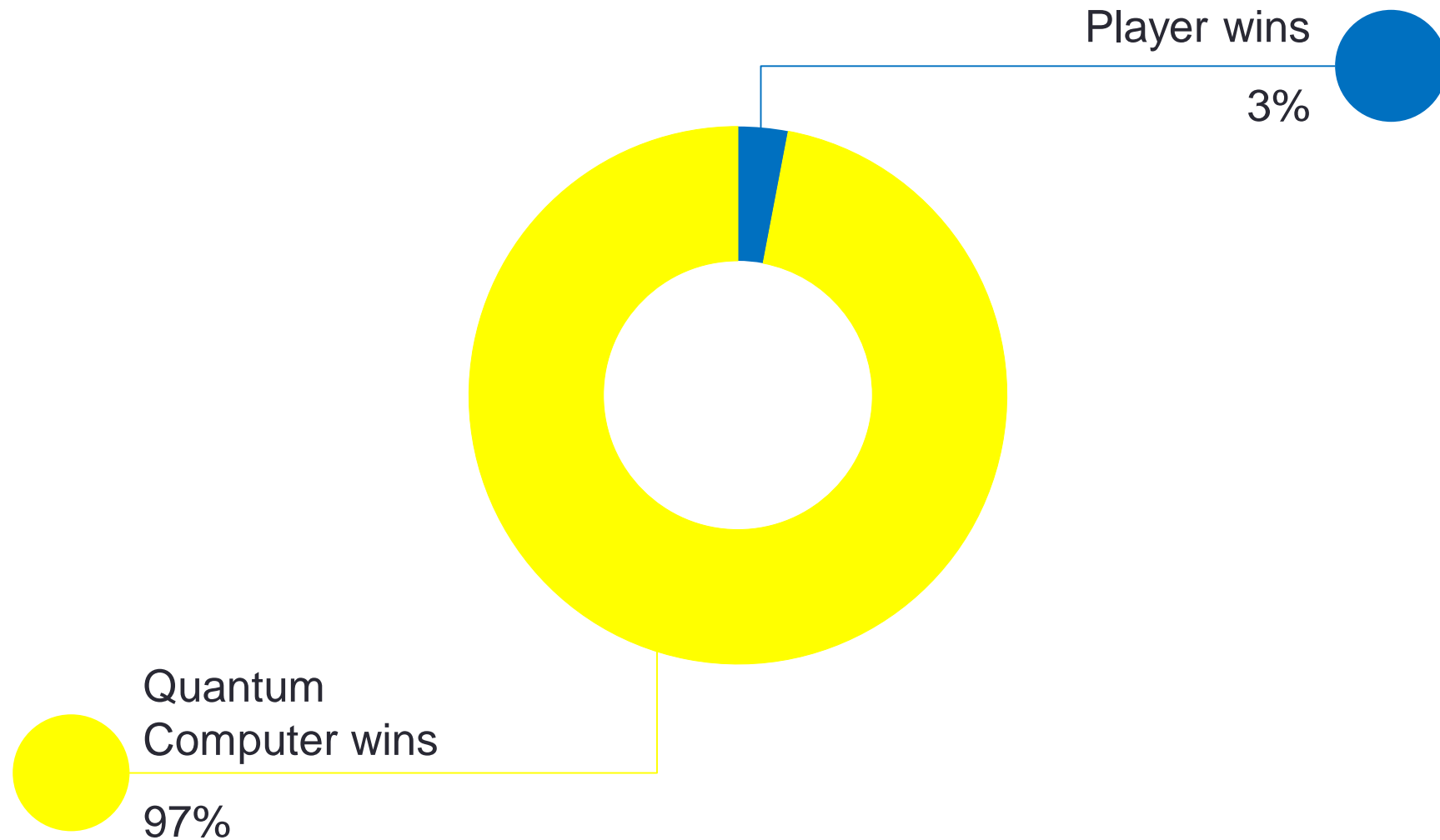
Potential Applications

Introduction to Quantum Computing
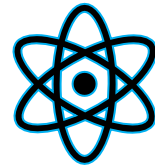
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Applications in Creating Private Keys for Encrypting Messages

To create advanced private keys for encrypting messages to deter and prevent hacking

Quantum simulations could lead to treatment of Alzheimer's disease, which affects millions of lives. (5.8 million in U.S.)
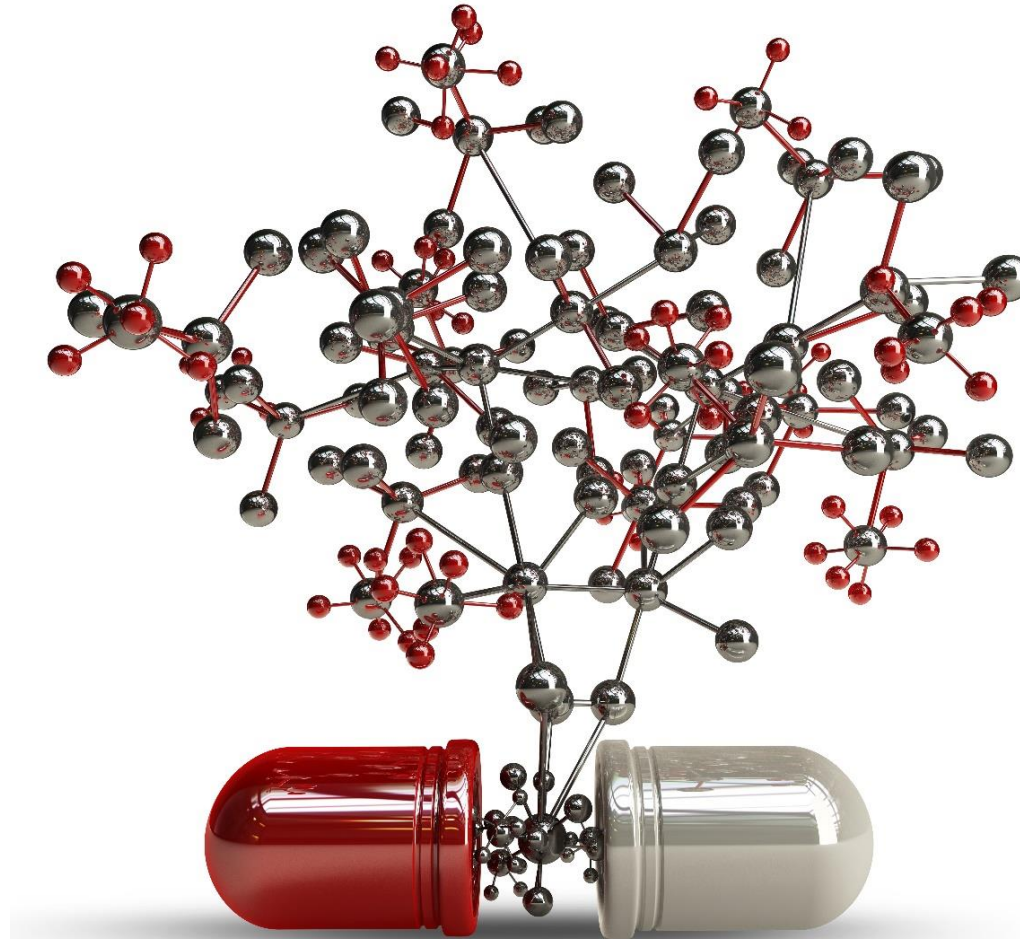
Application in Teleportation of Information

Teleportation of information without physically transmitting the information.

Potential Applications in Power Systems

Quantum computing is what the power system needs to manage the computing needs of the future

- New mathematical methods need to be developed and implemented for power grid analytics to make the necessary transformation adjustments. Quantum computing's advanced mathematical and computational capability is precisely what the power system needs to experience revolutionary adjustments at this critical time.

- Developing more comprehensive models that include the dynamic relationships between transmission and distribution systems will be essential in the future.

- Better scheduling models are needed to design viable deployment and use of distributed energy resources.

- The ability to embed sensing/computing/control at a component level is further becoming a necessity. Consequently, interconnected system models become critical to support communication and exchange of data between distinct layers of the system.

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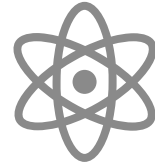
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- It is necessary to conduct comprehensive research on this emerging technology as an enabler and supporter of the green, reliable, resilient, and secure grid of the future.

- Analytics generally relate to the computer-based tools that are used to design transmission and distribution systems and to develop associated real-time control systems.

- The growing number of active players, such as microgrids, and the resulting complexity calls for revisiting the traditional computing methods and investigating innovative approaches that can address the needs of a modernized power grid.

Thank you

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