

2024 PROJECT PEER REVIEW

U.S. DEPARTMENT OF ENERGY
BUILDING TECHNOLOGIES OFFICE

BTO Peer Review: Super-Efficient Air-Conditioning Unit

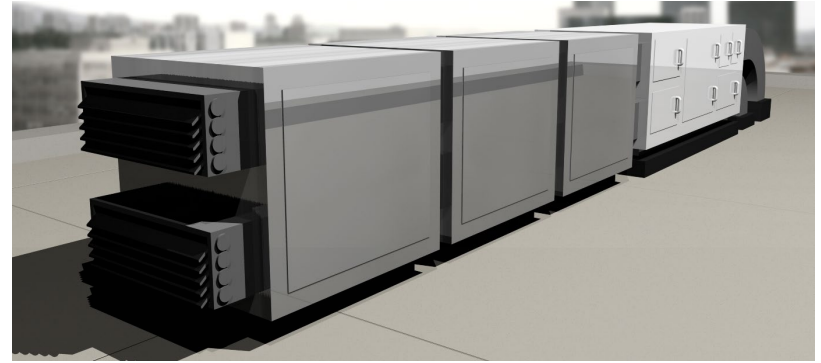
Performing Organizations: Baryon inc.,
Argonne National Laboratory, Oak Ridge
National Laboratory,
University of Illinois at Chicago
Presenting: Dr. Demis Pandelidis
PI: Jeffrey Premer
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FOA Project BENEFIT 2020 2196-1902



Project Summary

OBJECTIVE, OUTCOME, & IMPACT

- ESCCC cooling technology which allows to save from 50 up to 90% energy for air conditioning
- The technology is based on an unique two phase cooling process
- The technology is most efficient in humid climates



TEAM & PARTNERS

- Baryon inc.
- Argonne National Laboratory
- Oak Ridge National Laboratory
- University of Illinois at Chicago

STATS

Performance Period: 10.2022-10.2024

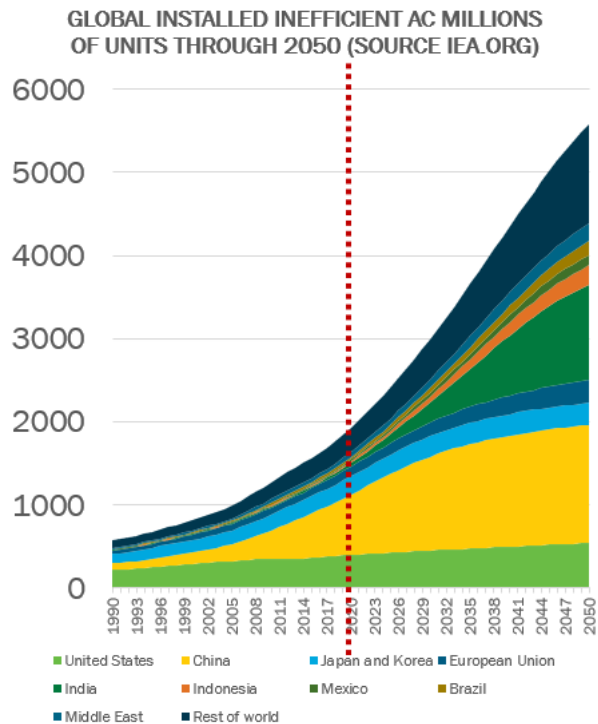
DOE budget: \$2,849,033, Cost Share: \$750,000

Go/No-Go 2: Demonstrate a laboratory-based prototype which will achieve $\geq 70\%$ of the target effectiveness during the experimental tests

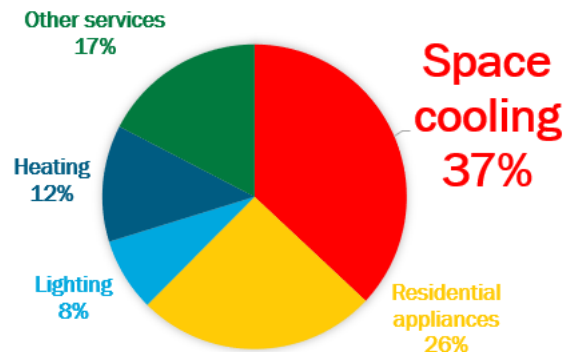
Final milestone: Air conditioning module with a capacity of 10 kW (34,120 Btu/hr) operating in a real environment achieving at 60-80% energy savings in comparison with the traditional system.



Problem



SHARE OF ELECTRICITY DEMAND GROWTH THROUGH 2050



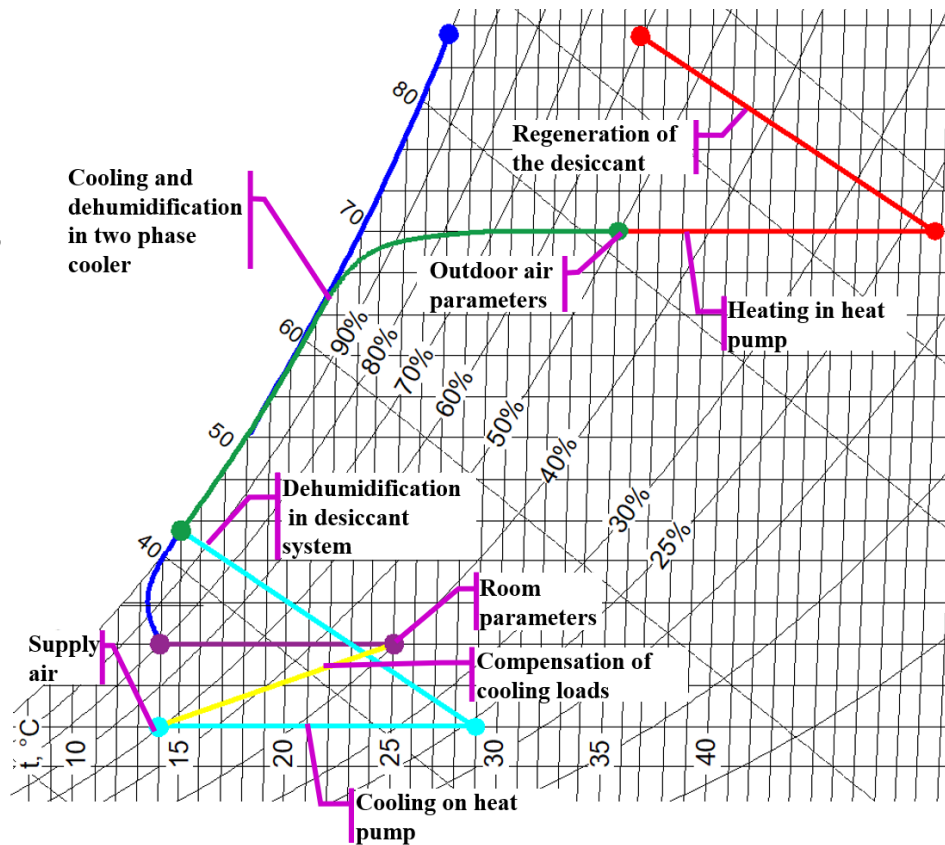
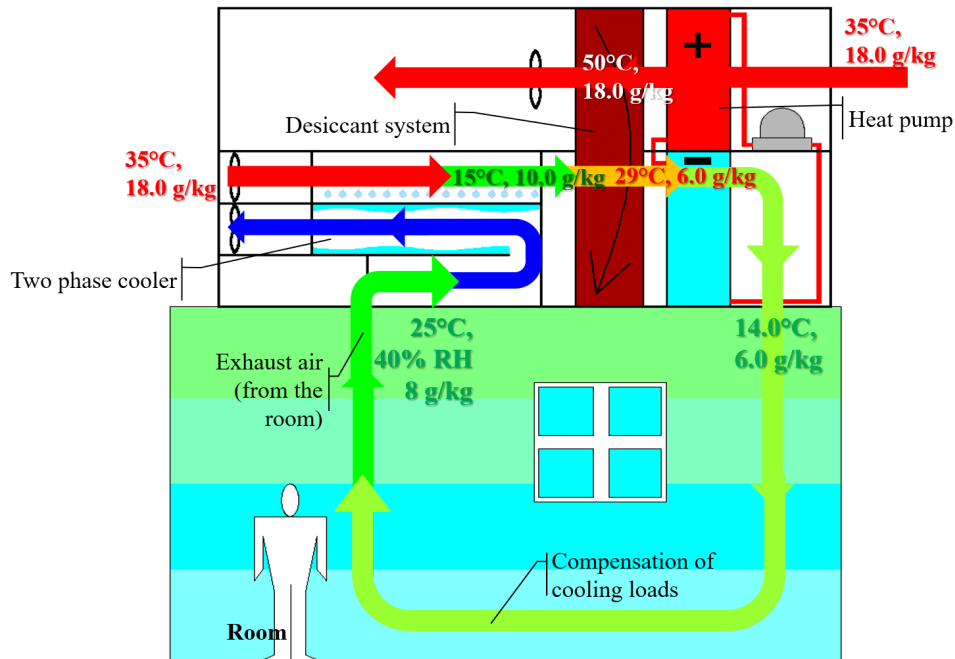


Alignment and Impact

- 1) **power consumption:** proposed unit can significantly decrease the energy consumed by air conditioning systems, with the cooling COP varying from 12.0 up to 30, which corresponds to 50-80% energy savings.,
- 2) **Highest effectiveness in humid climates:** the system is dedicated for humid climates, where most of the human population lives and where AC is a necessity. Air conditioning systems are responsible for 40-60% of the energy consumption in buildings in humid climates.
- 3) **New type of air cooler:** Two phase cooler in ESCCC uses dedicated mini-channel structure, special materials and dedicated water distribution system, which allows it to obtain very high effectiveness
- 4) **Universality:** the proposed system offers a complete temperature and humidity control solution which doesn't need any supplementary equipment (eg. Cooling towers, dry coolers etc.),
- 5) **Closed water cycle:** unique arrangement of the unit allows recover condensate from TPC and membrane unit for the purpose of evaporation,
- 6) **No mineral deposition:** TPC in the unit uses unique water distribution system, which allows to completely prevent the mineral formation in the wet channels, by using self-cleaning mechanism,
- 7) **100% fresh air:** proposed device supplies 100% fresh air stream to the building with minimal energy consumption (typical AC systems use 10% of fresh air). Fresh air creates a much healthier indoor environment (effective room ventilation is essential in minimizing the spread of bacteria and viruses, such as COVID-19),
- 8) **Lifetime:** the unit is passive, it is made of synthetic materials, its structure is less complicated than traditional systems. Due to this fact its expected life expectancy is 25-30 years compared to 10-20 of traditional AC.



Approach





Approach

Theoretical research

Numerical simulation of the crucial components

Initial validation of the models

Numerical simulation of the integrated system

Experimental research

Material testing

Water distribution testing

Crucial components testing

Prototype testing

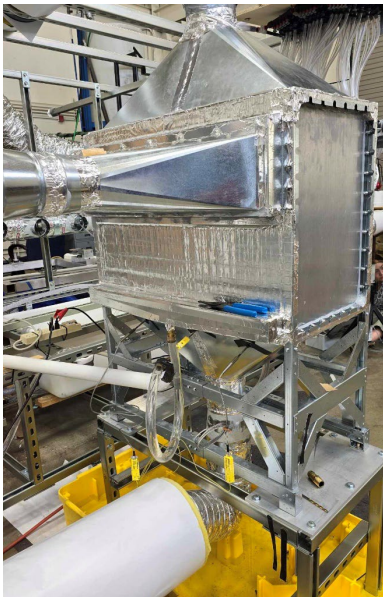
Integrated system testing





Approach

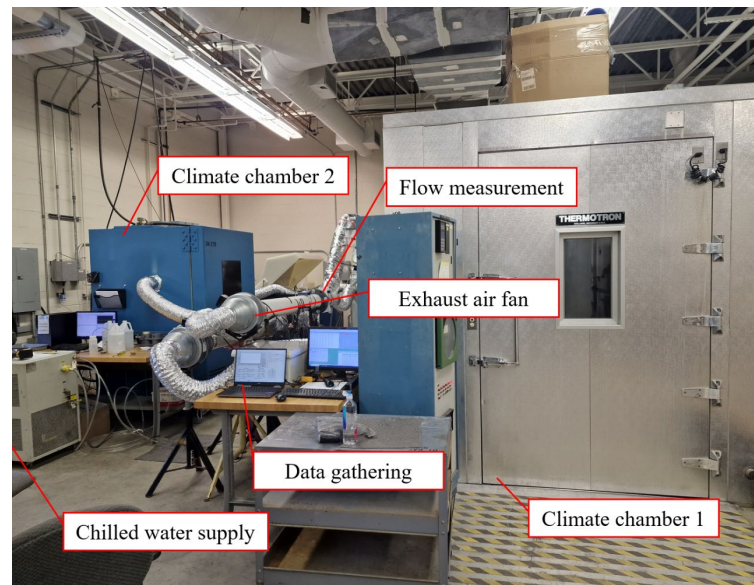
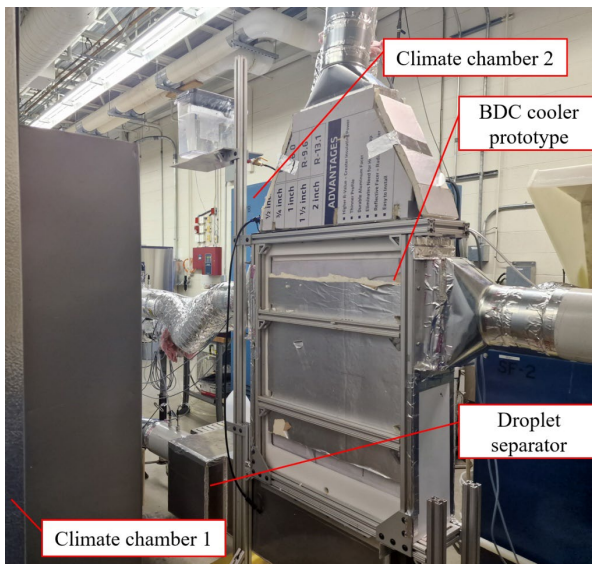
Improved prototypes development and testing





Approach

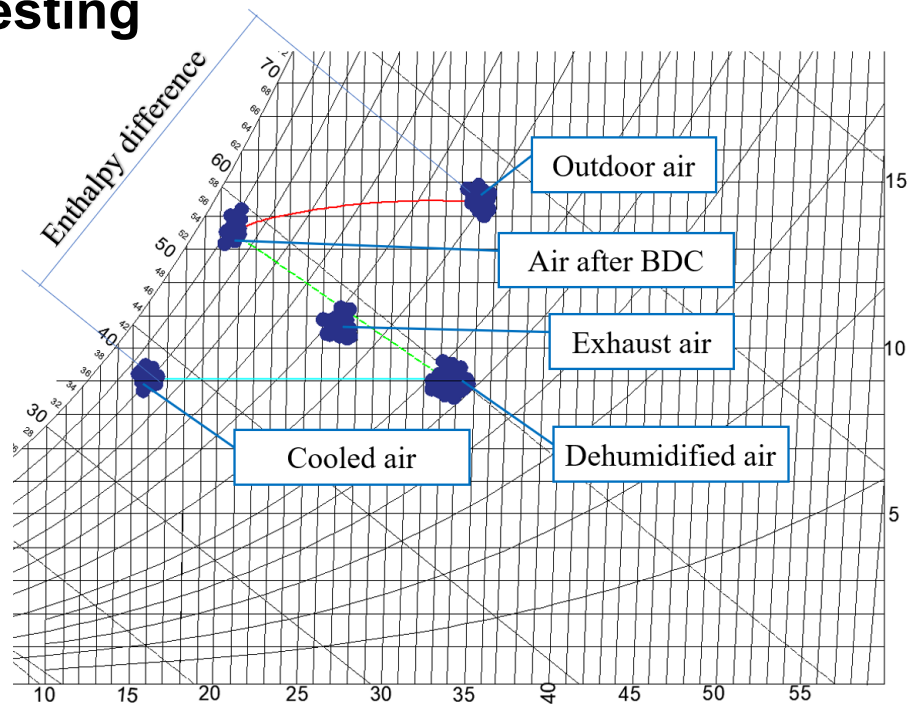
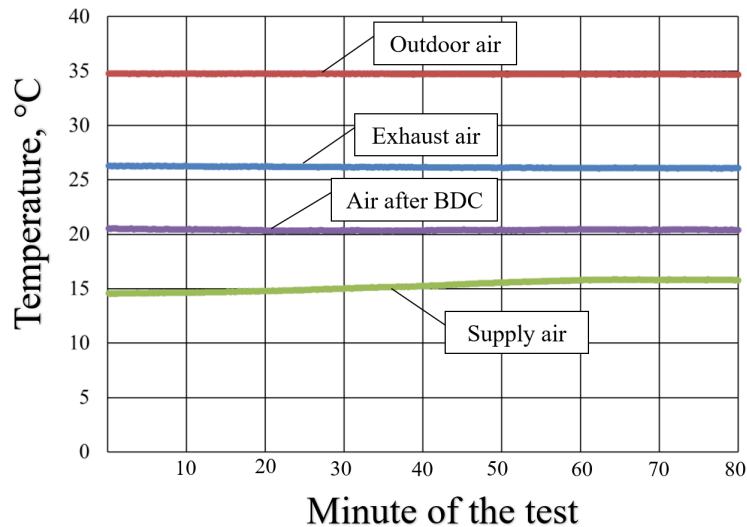
First prototype development and testing





Approach

First prototype development and testing





Approach

Improved prototypes development and testing





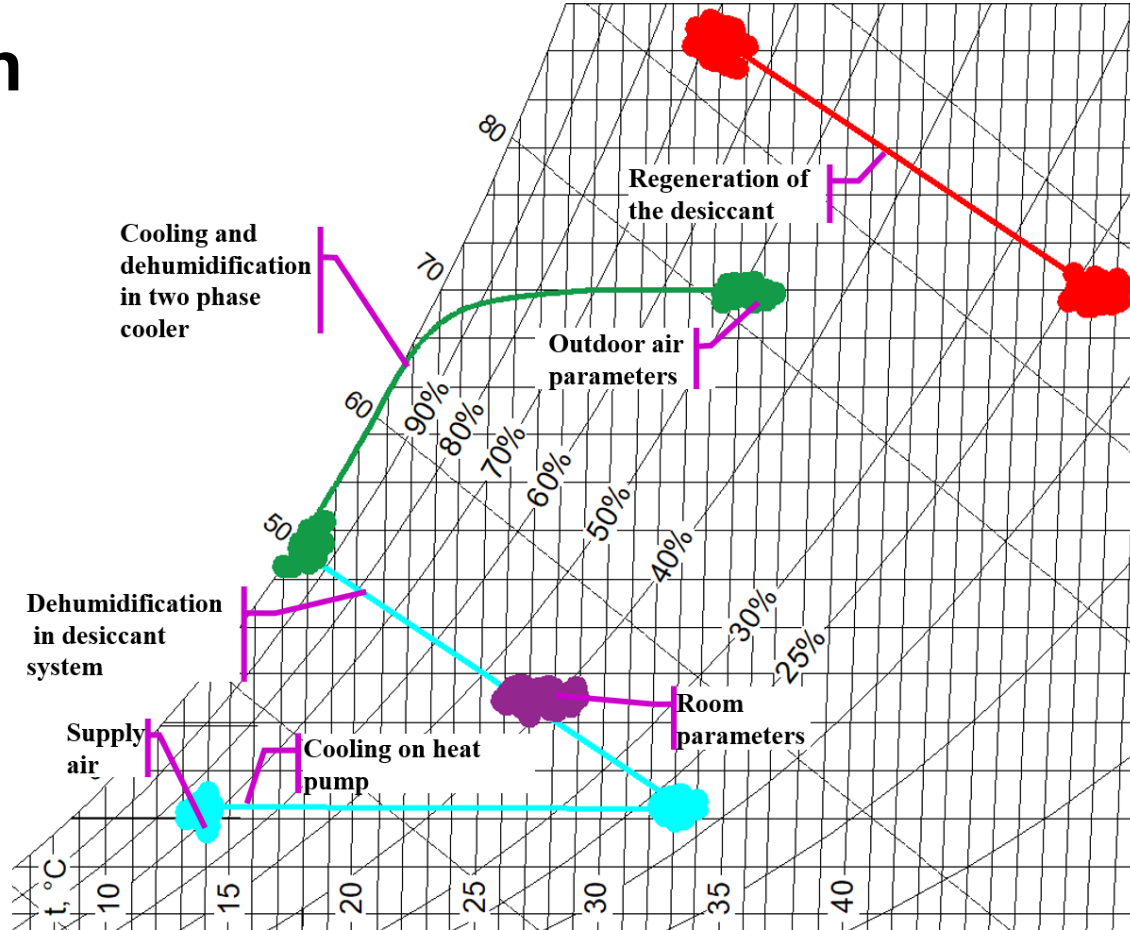
Approach

Improved prototypes development and testing





Approach





Approach

Supply temperatures after two phase cooler :17.1 to 18.5°C

Supply temperatures :12.1 to 14.5°C

90% of the target effectiveness achieved

COP thermal varying from 2.0 to 3.3

COP electrical varying from 9.1 to 11.1

89% of the target effectiveness achieved



Progress and Future Work

- *Go/No-Go 2: Demonstrate a laboratory-based prototype which will achieve $\geq 70\%$ of the target effectiveness during the experimental tests*
- *Final milestone: Air conditioning module with a capacity of 10 kW (34,120 Btu/hr) operating in a real environment achieving at 60-80% energy savings in comparison with the traditional system.*



Progress and Future Work





Progress and Future Work

- EU Licensee – district cooling
 - 10 year agreement signed
 - US multinational OEM
 - Commercial pilot April 2025
 - Mass production 2026
 - Anchor customer:
 - 4 billion Euro revenue utility
 - 5.7+ million customers
 - **Utility will sell cooling as a service to their customers**
 - Other customer discussions underway
- EU Licensee – pre-cooling
 - 10 year agreement signed
 - US multinational OEM
 - Commercial pilots underway
 - Mass production 2025
 - Many anchor customers (multi family home and office landlords)
 - High cost of energy in Europe (~0.25 Euro per kWh), **very fast 1 year payback**



Progress and Future Work



Thank you

Performing Organizations: Baryon inc., Argonne National Laboratory, Oak Ridge National Laboratory, University of Illinois at Chicago

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FOA Project BENEFIT 2020 and/or any other Project
2196-1902

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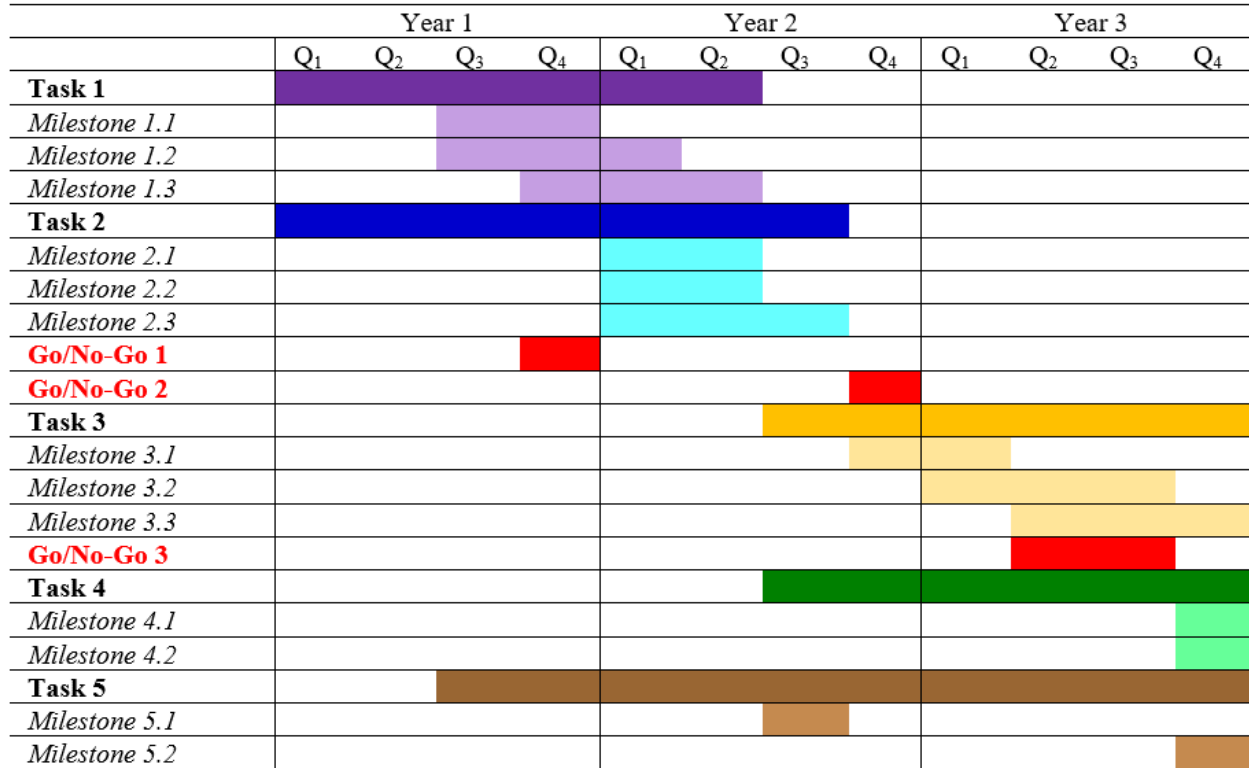
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Reference Slides





Project Execution





Team



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