

# HITEMMP – Tech to Market

*Guidance for completion of Phase 2 activities*

Presented at the Annual Review March 30, 2022

Rakesh Radhakrishnan

# Phase 2 – End of Phase Expectations

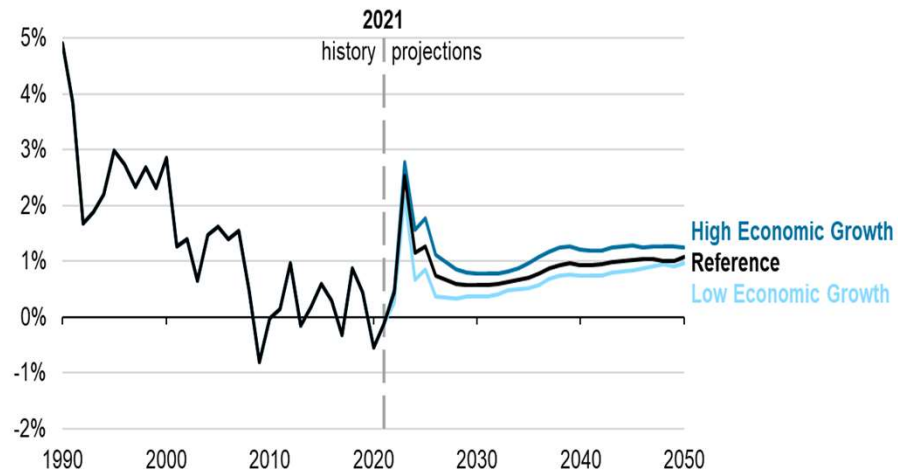


- ▶ Commercialization through a business:
  - IP strategy completed and position defined
  - Identified first and second market application
  - Preliminary cost model
  - Preliminary TEA to demonstrate value proposition in target applications
  - Identified key supply chain partners and customers
  - Identified resources to “scale up” the business
  - Begin work on your financial model
  
- ▶ Commercialization through licensing:
  - IP strategy completed and position defined
  - Work with a technology licensing expert to identify prospective licensors

# Stationary Power Market Outlook - US

## Forecasted Growth

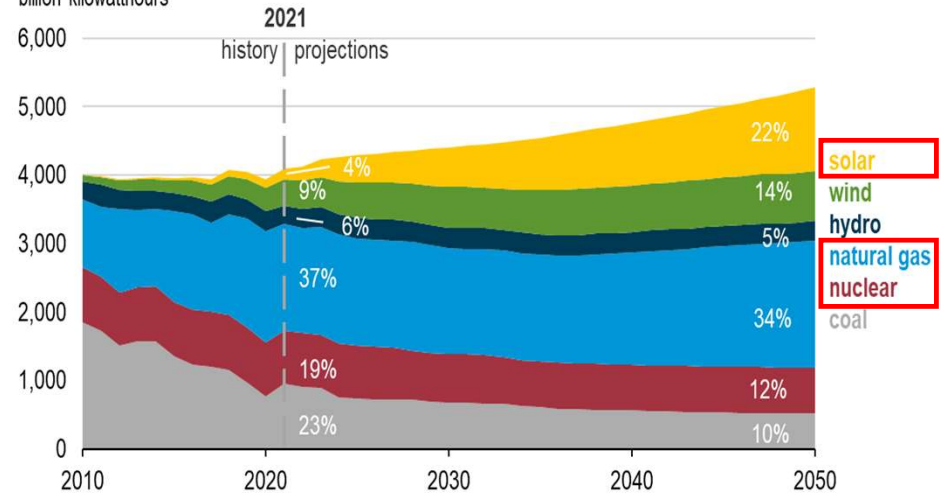
U.S. electricity use growth rate, three-year rolling average  
AEO2022 economic growth cases  
percentage growth



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2022* (AEO2022)

## Mix by Generation Type

U.S. electricity generation from selected fuels  
AEO2022 Reference case  
billion kilowatthours



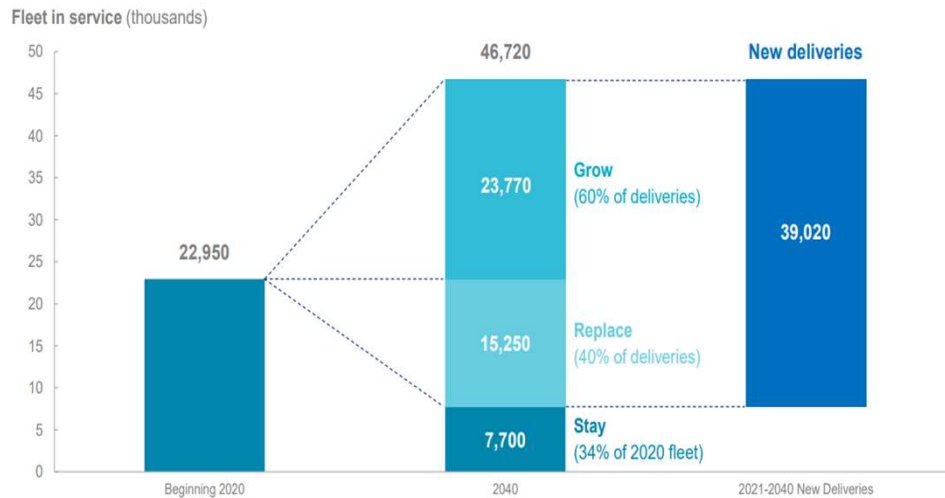
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2022* (AEO2022) Reference case  
Note: Solar includes both utility-scale and end-use photovoltaic electricity generation.

- 1.5% \* 1 TW ~ 15 GW annually, TAM ~50% -> 8 GW/yr
- What % of this market will be serviced by sCO2 cycles and when?
- Applications in conventional systems and at what price?

# Aviation Market Outlook - Global

## Forecasted Growth

Demand for some 39,000 aircraft over the next 20 years



Notes: Passenger aircraft (>100seats) & Freight (>10t) | Rounded figures to nearest 10  
Source: Airbus GMF 2021

AIRBUS

## Mix by Aircraft Type

Out of the 2021-2040 demand, 76% is for small aircraft category

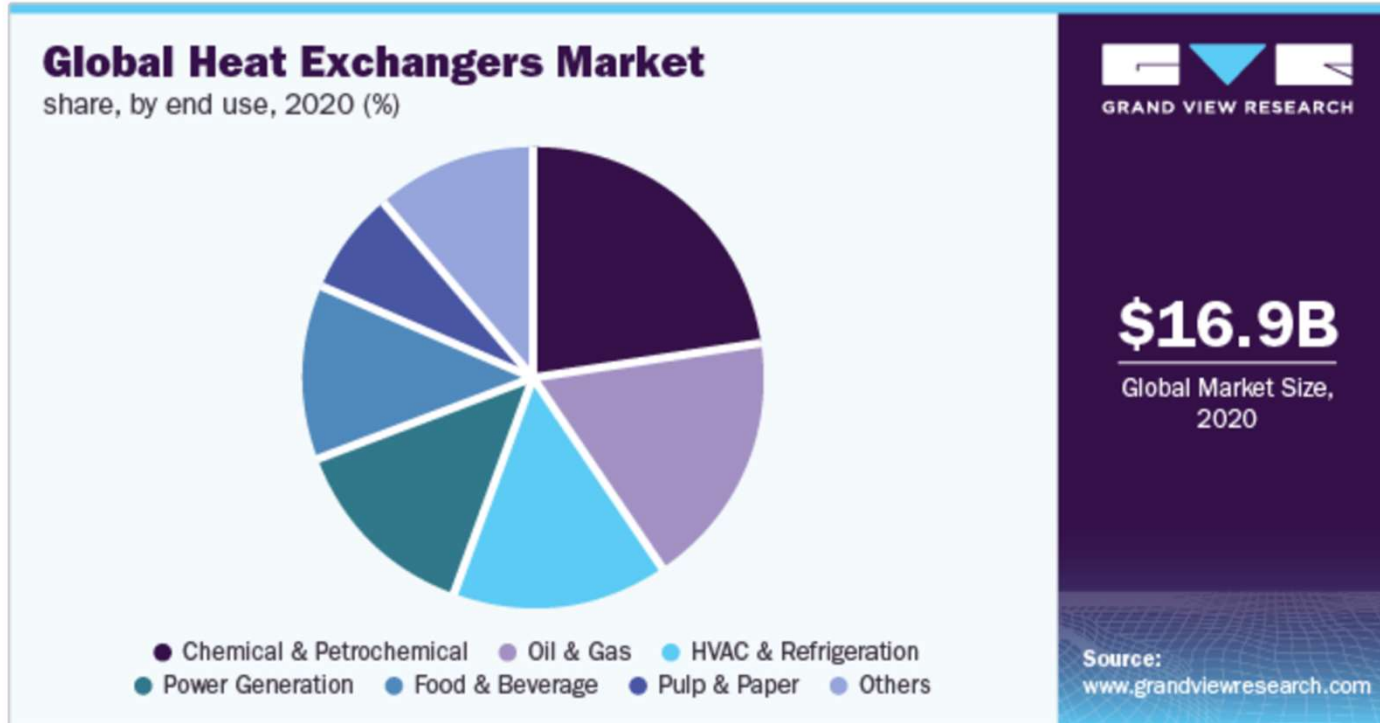


Jet Passenger aircraft >=100 seats and Freight >=10 tons  
Source: Airbus Market Forecasts  
Note: demand for all commercial aircraft above 100 seats & freighters above 10t

AIRBUS

- 40 K demand over 20 years -> 2 K aircraft per year
- What % of this market will be serviced by sCO2 cycles and when?
- Applications in conventional cycles and at what price?

# Application in Other Markets?



- Report forecasts ~4% growth from 2020 to 2028
- Value proposition in higher temperature applications?
- Identifying technical and price requirements / application specific

# What is your CRL?

## APPENDIX B - COMMERCIAL READINESS LEVEL SCALE

Please note that proposed technologies are not expected to be commercially mature at the start of the project period, nor must any specific CRL be reached by the project's end.

CRL	Description
1	Knowledge of applications, use-cases, & market constraints is limited and incidental, or has yet to be obtained at all.
2	A cursory familiarity with potential applications, markets, and existing competitive technologies/products exists. Market research is derived primarily from secondary sources. Product ideas based on the new technology may exist, but are speculative and unvalidated.
3	A more developed understanding of potential applications, technology use-cases, market requirements/constraints, and a familiarity with competitive technologies and products allows for initial consideration of the technology as product. One or more "strawman" product hypotheses are created, and may be iteratively refined based on data from further technology and market analysis. Commercialization analysis incorporates a stronger dependence on primary research and considers not only current market realities but also expected future requirements.
4	A primary product hypothesis is identified and refined through additional technology-product-market analysis and discussions with potential customers and/or users. Mapping technology/product attributes against market needs highlights a clear value proposition. A basic cost-performance model is created to support the value proposition and provide initial insight into design trade-offs. Basic competitive analysis is carried out to illustrate unique features and advantages of technology. Potential suppliers, partners, and customers are identified and mapped in an initial value-chain analysis. Any certification or regulatory requirements for product or process are identified.
5	A deep understanding of the target application and market is achieved, and the product is defined. A comprehensive cost-performance model is created to further validate the value proposition and provide a detailed understanding of product design trade-offs. Relationships are established with potential suppliers, partners, and customers, all of whom are now engaged in providing input on market requirements and product definition. A comprehensive competitive analysis is carried out. A basic financial model is built with initial projections for near- and long-term sales, costs, revenue, margins, etc.
6	Market/customer needs and how those translate to product needs are defined and documented (e.g. in market and product requirements documents). Product design optimization is carried out considering detailed market and product requirements, cost/performance trade-offs, manufacturing trade-offs, etc. Partnerships are formed with key stakeholders across the value chain (e.g. suppliers, partners, customers). All certification and regulatory requirements for the product are well understood and appropriate steps for compliance are underway. Financial models continue to be refined.
7	Product design is complete. Supply and customer agreements are in place, and all stakeholders are engaged in product/process qualifications. All necessary certifications and/or regulatory compliance for product and production operations are accommodated. Comprehensive financial models and projections have been built and validated for early stage and late stage production.
8	Customer qualifications are complete, and initial products are manufactured and sold. Commercialization readiness continues to mature to support larger scale production and sales. Assumptions are continually and iteratively validated to accommodate market dynamics.
9	Widespread deployment is achieved.

# Preparing for Technology Transition

---

- ▶ Objective: Finalize a pitch targeted towards investors (internal business units for large companies, ARPA-E M37, incubator competitions etc.)
- ▶ **Slide 1: Opportunity summary** (markets, value proposition, competitive landscape/TEA)
- ▶ **Slide 2: Technology details** (uniqueness, IP position, readiness level)
- ▶ **Slide 3: Business scaleup** (five year business plan and financial model)
- ▶ **Slide 4: Team** (C-suite, org chart, build out plan)
  
- ▶ Refined cost and TEA models
  
- ▶ Manufacturing scale up plan

# Q & A



U.S. DEPARTMENT OF  
**ENERGY**

<https://arpa-e.energy.gov>