

UNITED ENGINE CORPORATION ADDITIVE TECHNOLOGY



*Объединенная
Двигателестроительная
Корпорация*

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GOALS OF UNITED ENGINE CORPORATION



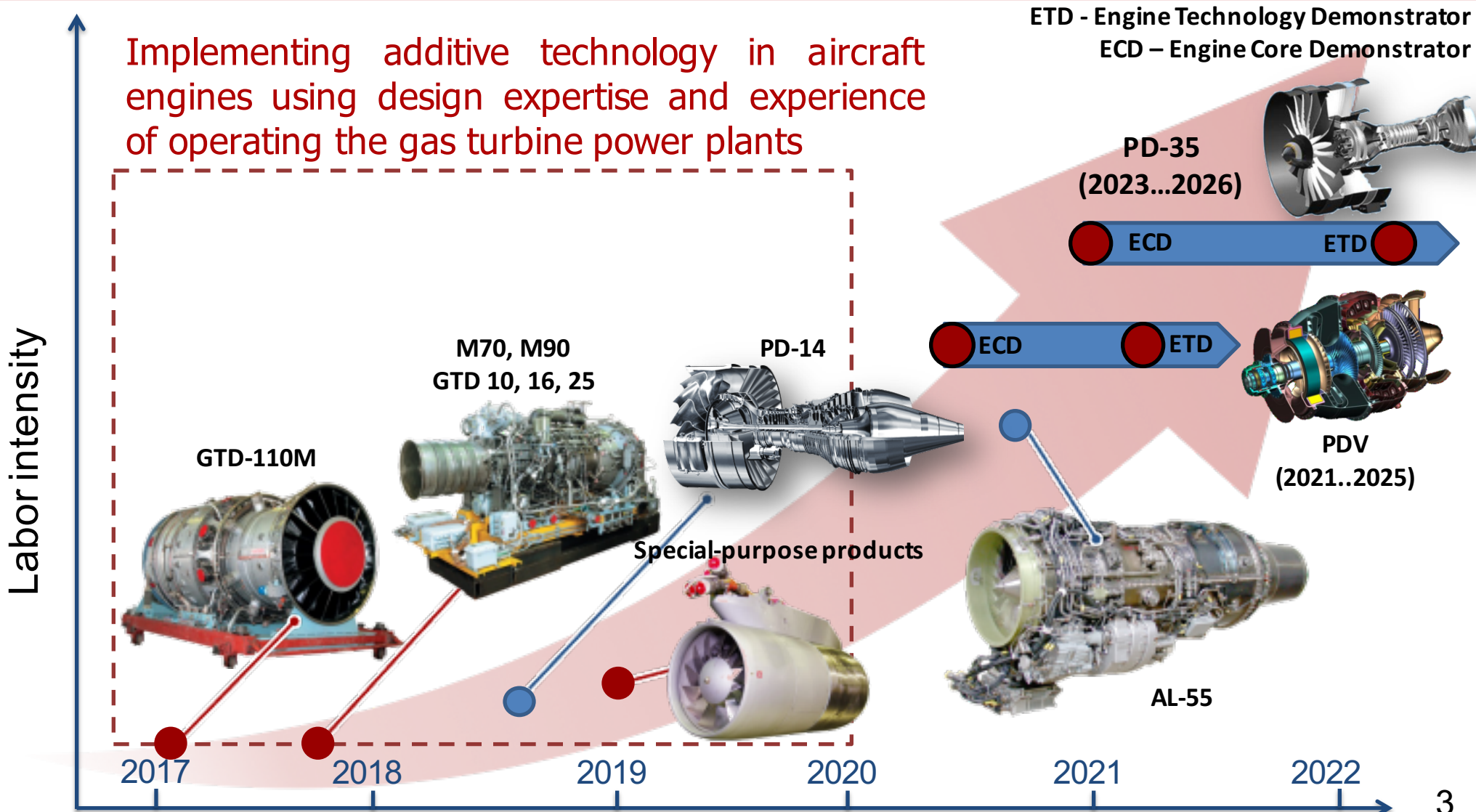
The following goals should be reached by 2030:

1. New engines certified after 2018 will have up to 20% (in terms of weight) of parts designed and manufactured using additive technology.
2. The number of an engine's parts and assembly units will be decreased more than two fold using new design technology, including topology optimization.
3. Due to reduction of time and costs required for production engineering, the development time of test engines manufactured using additive technology will be reduced by 80%.
4. The duration of production cycle for off-the-shelf parts designed and manufactured using additive technology will decrease three times, while their cost will decrease by half.

FROM SIMPLE TO COMPLEX



Implementing additive technology in aircraft engines using design expertise and experience of operating the gas turbine power plants



CURRENT STATUS



TRL = 9

GTD-110, 110M



Parts of the combustion chamber

TRL = 8

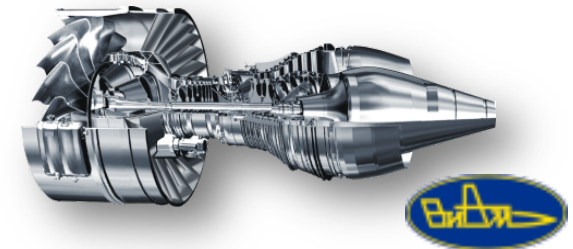
Marine engines and gas turbine power plants



Parts:
Combustion chamber
Heavy-duty brackets
Gas distribution device
High-pressure compressor guide vanes

TRL = 7

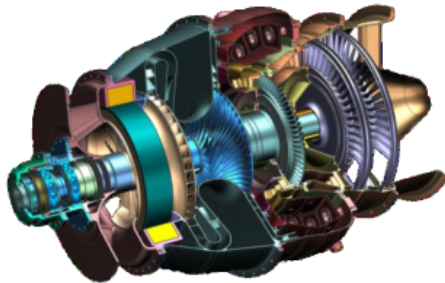
PD-14



Parts of the combustion chamber

PDV

(2021 – technology demonstration)



Parts:

- compressor
- combustion chamber
- turbines
- rotor support
- heavy-duty brackets

Dimensions of the engine allow using a wide range of parts manufactured using additive technology

PD-35

(2023 – technology demonstration)

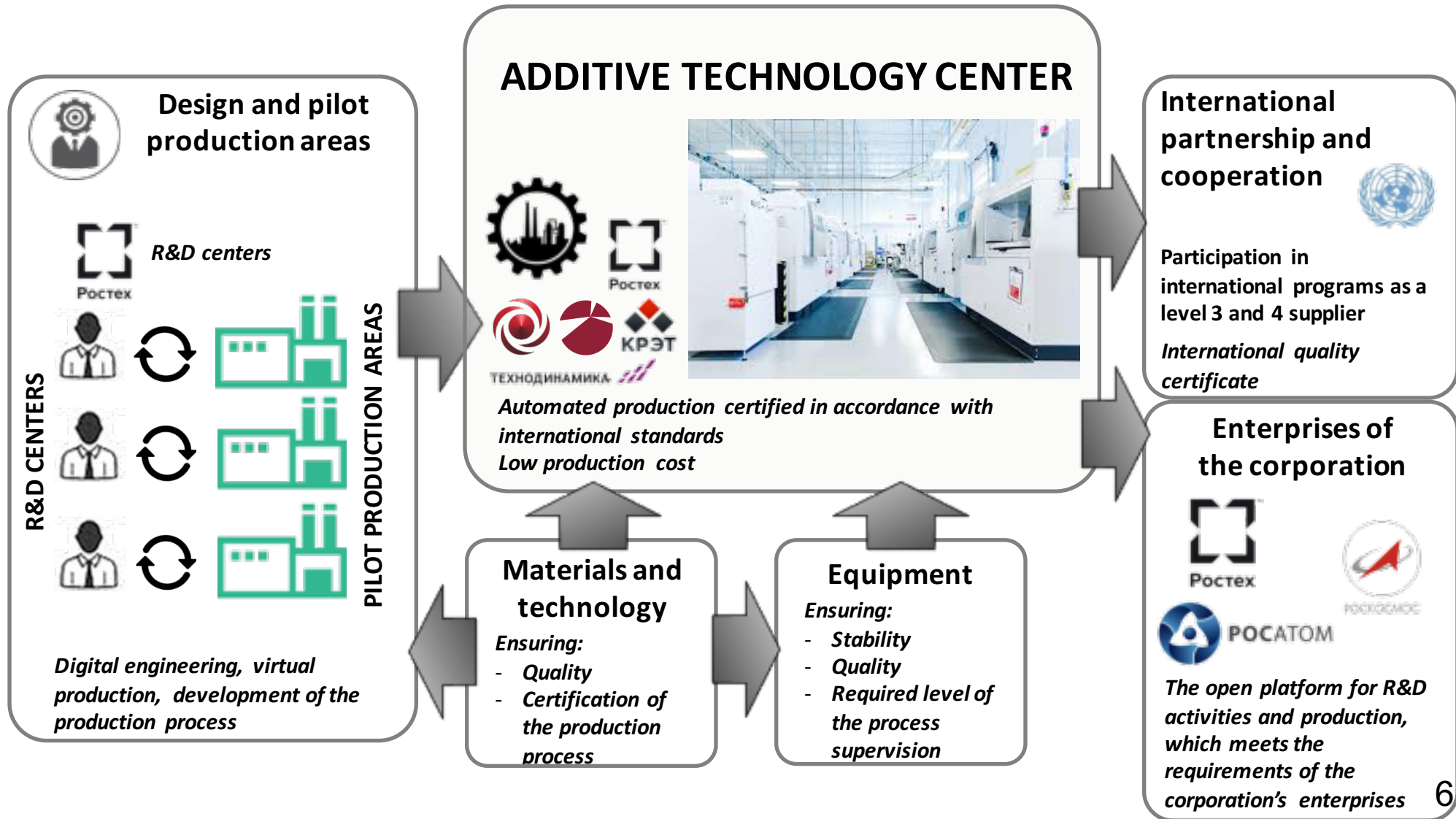


Parts:

- compressor
- combustion chamber
- turbines
- rotor support
- heavy-duty brackets

Dimensions of the engine require an R&D project to be carried out in order to develop a technology for production of large-scale parts

ADDITIVE MANUFACTURING CENTER OF THE ROSTEC CORPORATION

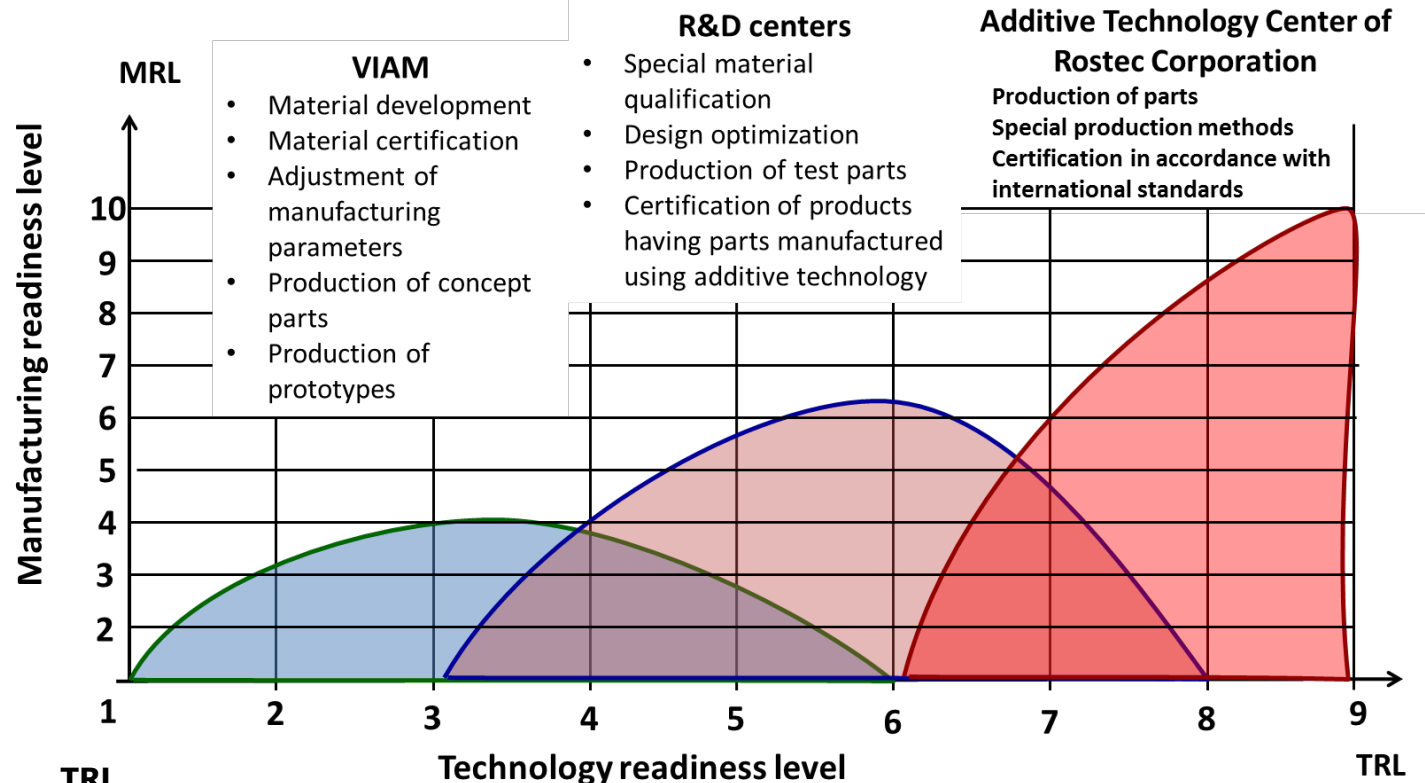


DEFINING THE AREAS OF RESPONSIBILITY



MRL

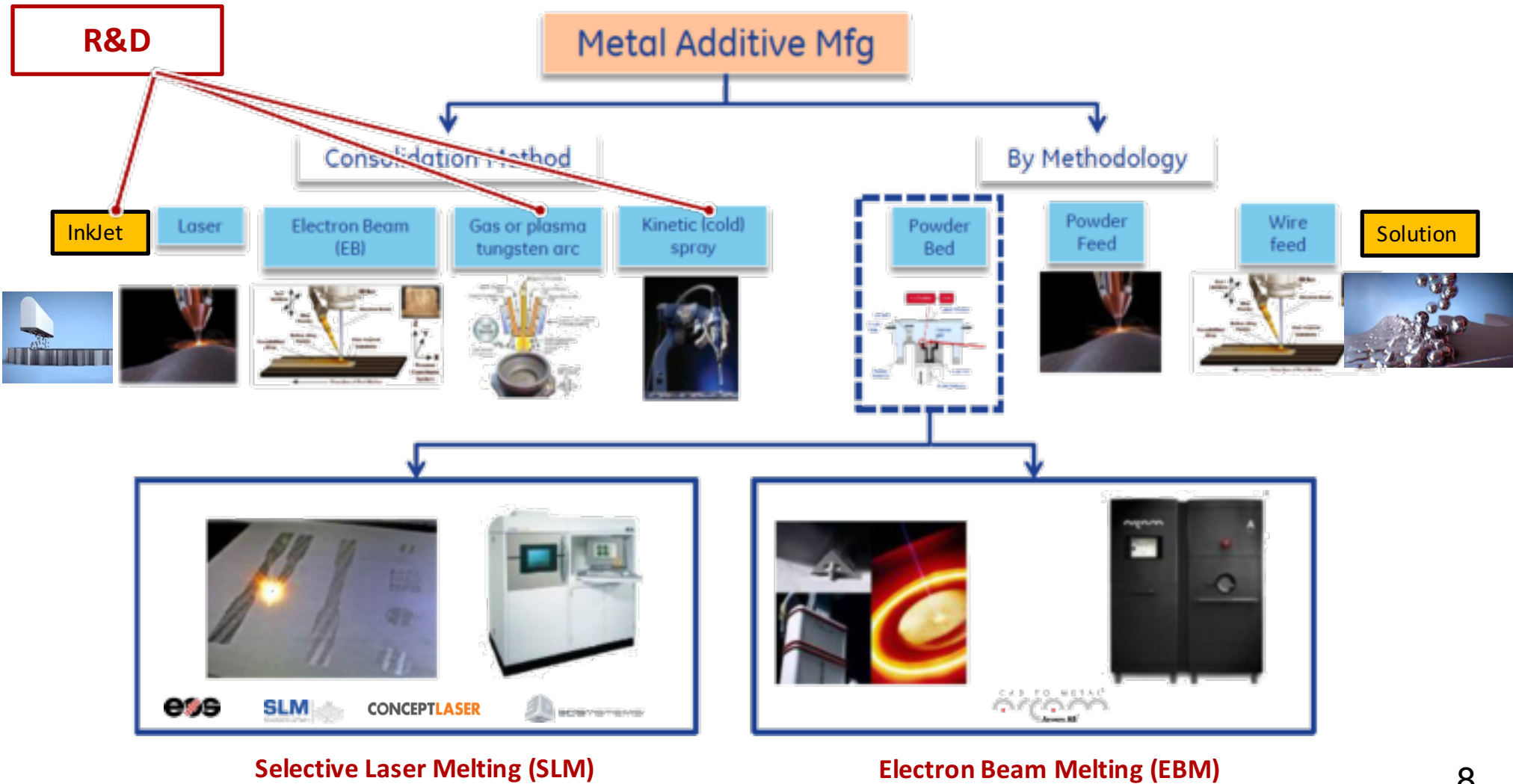
- 3 – Manufacturing proof of concept developed
- 4 – Capability to produce the technology in a laboratory environment.
- 5 – Capability to produce prototype components in a production relevant environment.
- 6 – Capability to produce a prototype system or subsystem in a production relevant environment.
- 7- Capability to produce systems, subsystems or components in a production representative environment.
- 8- Pilot line capability demonstrated. Ready to begin low rate production.
- 9 – Low rate production demonstrated. Capability in place to begin Full Rate Production.
- 10 – Full rate production demonstrated and lean production practices in place.



TRL

- 1 – Basic principles observed and reported
- 2 - Technology concept and/or application formulated
- 3 - Analytical and experimental critical function and/or characteristic proof of concept
- 4 – Component and/or breadboard validation in laboratory environment
- 5 – Component and/or breadboard validation in relevant environment
- 6 – System/subsystem model or prototype demonstration in a relevant environment
- 7 – System prototype demonstration in an operational environment.
- 8 – Actual system completed and qualified through test and demonstration.
- 9 – Actual system proven through successful mission operations.

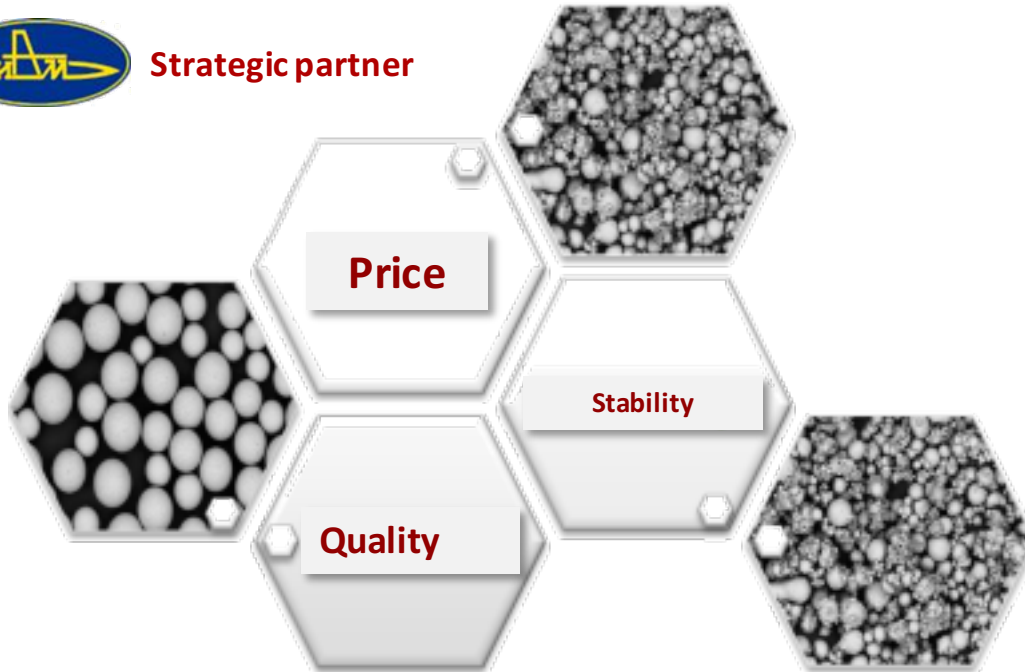
OFF-THE-SHELF ADDITIVE TECHNOLOGY



METAL-POWDER COMPOSITIONS

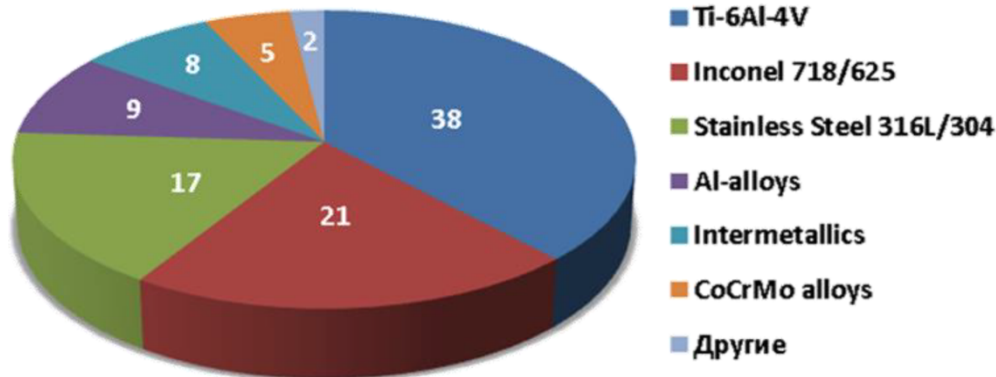


Strategic partner

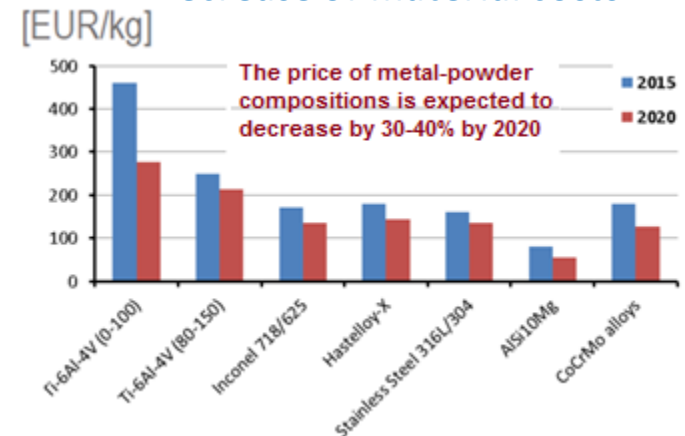


- The most widely-used types of materials have been defined
- Five types of materials have been selected for implementing additive technology in gas turbine engines:
 - nickel (EP648, VZh157),
 - cobalt (CoCrMo),
 - titanium (VT6),
 - aluminum (AlSi10Mg)
 - stainless steel(SS15.5 and similar)
- Using new materials for additive manufacturing should ensure dramatic change of the parts' characteristics

Distribution of the world's consumption of materials

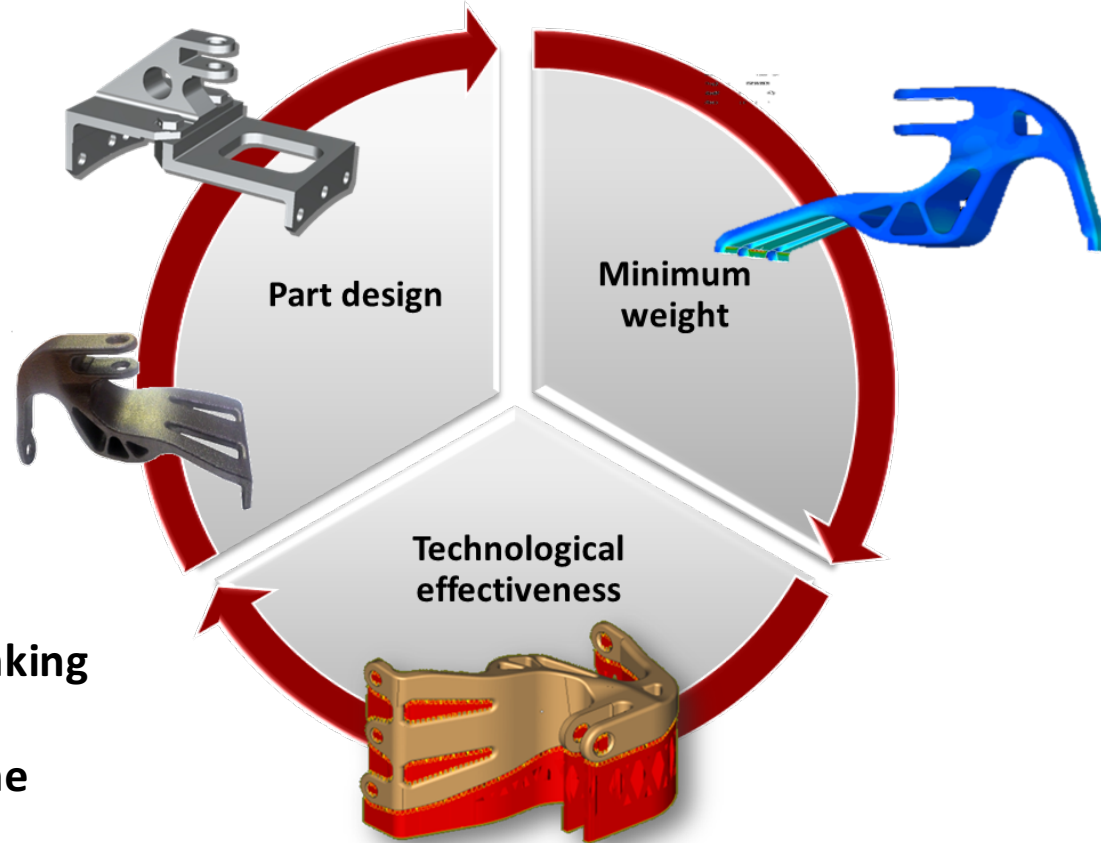


Decrease of material costs





The necessity of changing the designer's thinking using production experience.
Pilot production areas are located close to the R&D center



Establishing the designed centers developing parts manufactured using additive technology is one of the UEC's top-priority objectives

1. The current state of the United Engine Corporation shows maturity of the additive technology and readiness to start the full rate production of parts, which have passed special and certification tests as components
2. The latest projects of UEC (PD-35 and PDV) are targeted at wide use of parts manufactured using additive technology (up to 20% in terms of weight), both the already developed ones and new ones, which require some R&D activities
3. Rostec Corporation's companies have established the Additive Technology Center focused on production and repair of metal parts as well as design projects and support of expertise of the Corporation's employees and other interested companies
4. Additive Technology Center is one of UEC's platforms for developing the processes of the "Smart Factory"
5. Wide use of additive technology requires the accelerated development of potential of design bureaus and pilot production areas
6. Technologies for certain materials and equipment, including CNC data, will be developed in cooperation with research institutes.