Clean Sky : Innovative aeronautics powering a stronger Europe

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Académie de l'Air et de l'Espace, 7
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Innovation Takes Off

GENT

EUROPEAN LANDSCAPE OF RESEARCH AND INNOVATION

Version dd. 13/10/2015

European Innovation Partnerships (EIPs) - no funding - EC initiatives - bring different actors together – develop Strategic Implementation Plan (SIP) - launch calls for commitment

- EIP-AHA on Active and Healthy Ageing
- EIP-Agriculture on Agricultural Sustainability and Productivity
- EIP on Water
- EIP-SCC on Smart Cities and Communities
- EIP-RARE on Raw Materials

Public to Public Partnerships (P2Ps) - EC and Member States (MS)

Joint Programming Initiatives (JPIs)

- Virtual common pot
- develop Strategic Research and Innovation Agenda (SRIA) or Strategic Implementation Plan (SIP)
- Pilot action:
  - SET plan - The European Strategic Energy Technology Plan
  - JP ND (Neurodegenerative Disease Research)
  - JPI-HDHL (A Healthy Diet for a Life) Healthy
  - More Years, Better Lives - The Potential and Challenges of Demographic Change
  - JPI-AMR - The Microbial Challenge - An emerging Threat to Human Health
  - FACCE (Agriculture, Food Security and Climate Change)
  - JPI Oceans - Healthy and Productive Seas and Oceans
  - Urban Europe - Global Urban Challenges, Joint European Solutions
  - JPI Climate - Connecting Climate Knowledge for Europe
  - Water JPI - Water Challenges for a Changing World
  - JHEP (Cultural Heritage and Global Change: a new challenge for Europe)

ERA-NETs

Virtual common pot

Search: ERA-LEARN

- ANIHWA
- BiodivERsA3
- CAPITA
- CHIST-ERA II
- CIRCLE-2
- COFASP
- E-Rare-3
- ECO-INNOVERA
- Electromobility+
- EMRP
- ENTIII
- ERA-IB-2
- NEURON II
- ERAFRICA
- ERANID
- EuroTransBio
- EURONANOMED II
- HERA JRP CE
- TRANSCAN-2
- Infect-ERA
- M-ERA.NET
- MANUNET II
- OLAE+
- SEAS-ERA
- SOLAR-ERA.NET
- SNOWMAN
- ...
- ...

Article 185 initiatives

- Real common pot
- EC supports/participates in research programmes undertaken jointly by several MS
- EDCTP - European and Developing Countries Clinical Trial Partnership
- AAL - a joint research programme on 'Active and Assisted Living';
- EMPIR - a joint research programme in the field of Metrology (the science of measurement).
- Eurostars - a joint research programme for research-performing SMEs and their partners.
- Bonus - a joint research programme in the field of Baltic Sea research;

EUREKA clusters

- long-term, strategically significant industrial initiatives
- virtual common pot
- CATRENE (2008-2016)
- EURIPIDES² (2013-2020)
- ITEA 2 (2006-2014)
- EUROGIA2020 (2013-2020)
- CELTIC Plus (2011-2019)
- ACQUEAU (2010-2015)

Horizon 2020 (EU Framework Programme)

I. Excellent Science Pillar

- European Research Council (ERC)
- Marie Sklodowska Curie Actions (MSCA)
- Future and Emerging Technologies (FETs)
- Research Infrastructures (RI)

II. Industrial Leadership Pillar

- Leadership in Enabling and Industrial Technologies (LEIT)
  - ICT
  - Nanotechnologies
  - Advanced Manufacturing and Processing
  - Advanced Materials
  - Biotechnology
  - Space
- Access to risk finance
- Innovation in SMEs

III. Societal Challenges Pillar (SC)

- (SC1) Health, Demographic Change and Wellbeing
- (SC2) Food Security, Sustainable Agriculture, Marine and Maritime Research and the Bio-Economy
- (SC3) Secure, Clean and Efficient Energy
- (SC4) Smart, Green and Integrated Transport
- (SC5) Climate Change, Resource Efficiency and Raw Materials
- (SC6) Inclusive, Innovative and Reflective Societies
- (SC7) Secure societies - protecting freedom and security of Europe and its citizens

Cross-cutting issues:

- Spreading Excellence and Widening Participation
- Science with and for Society

European Institute of Innovation and Technology (EIT)

Euratom

Public private partnerships (ppps) - EC and industry

Contractual Public Private Partnerships (cPPPs) – part of Horizon 2020 Industrial Leadership Pillar

- industry sets agenda
- within Horizon 2020
- EeB – Energy Efficient Buildings
- FoF - Factories of the Future
- EGVI – European Green Vehicles Initiative
- SPIRE - Sustainable Process Industry through Resource and Energy Efficiency
- 5G (Advanced 5G for Future Internet)
- Photonics
- Robotics
- High Performance Computing

Key Enabling Technologies (KETs)

Cross-cutting actions under Industrial Leadership Pillar

- nanotechnology
- micro- and nanoelectronics including semiconductors
- advanced materials
- biotechnology
- photonics
- advanced manufacturing

Joint Technology Initiatives (JTIs)

- industry sets agenda
- externalized ppps with own Rules for Participation
- managed by a Joint Undertaking (JU)
- IMI2 - Innovative Medicines Initiative
- ECSEL
  - ENIAC - nanoelectronics
  - ARTEMIS - R&D in embedded systems
- FCH2 - Fuel cells and Hydrogen
- CS2 - Clean Sky
- BBI - Biobased and Renewable Industries for Development and Growth in Europe

Joint Undertakings

- SESAR
- Shift2Rail (tbc)

Programme for the Competitiveness of enterprises and SMEs (COSME)

- Better access to finance for SMEs
- Access to markets
- Support to entrepreneurs
- More favorable conditions for business creation and growth

European Structural and Investment Fund (ESIF)

Cohesion Policy

In your country

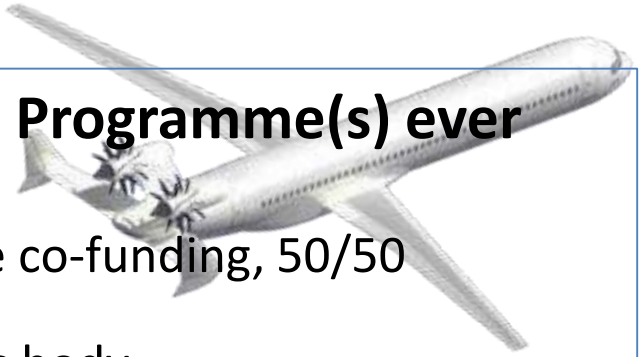
- European Regional Development Fund (ERDF) (i.a. Interreg)
- European Social Fund (ESF)
- European Agricultural Fund for Rural Development (EAFRD)
- European Maritime and Fisheries Fund (EMFF)
- Cohesion Fund (only for less developed Member States)

COST (European Cooperation in Science and Technology) - funding for networking for researchers

European Technology Platforms (ETPs) - no funding - industry-led stakeholder fora - develop SRIAs and Implementation Plans - labelled by the European Commission

Bio-based economy	Energy	Environment	ICT	Production and processes	Transport	Cross ETP Initiatives
EATIP (Aquaculture Technology)	Biofuels	WssTP (Water Supply and Sanitation)	ARTEMIS (Embedded Systems)	ECTP (Construction Technology)	ACARE (Aviation)	Nanofutures (Nanotechnology)
ETPGAH (Global Animal Health)	EU PV TP (Photovoltaics)		EUROP (Robotics)	ESTEP (Steel Technology)	ERRAC (Rail)	Industrial Safety (Occupational Diseases and Work-related Accidents)
Food for Life	TPWind (Wind Energy)		ETP4HPC (High Performance Computing)	EuMaT (Advanced Engineering)	ERTRAC (Road Transport)	
Forest-based Sector	RHC (Renewable Heating and cooling)		ENIAC (Nanoelectronics)	FTC (Textiles and Clothing)	Logistics	
Plants for the Future	SmartGrids		EPoSS (Smart Systems Integration)	SusChem (Sustainable Chemistry)	Waterborne	
FABRE TP (Farm animal breeding			ISI (Integral Satcom Initiative)	Nanomedicine		

Clean Sky : Innovation takes off



Europe's largest Aeronautics Research Programme(s) ever

- A ***Joint Technology Initiative*** with public-private co-funding, 50/50
- Managed by a "Joint Undertaking", autonomous body
- Integrated technologies, industry-led, up to **full scale demonstrators**
- **Environment and competitiveness objectives**
- Clean Sky 2 programme started in 2014, with 4 B€ total funding (most of EU aeronautical R&I funding)
- Organized through 6 technological platforms led by the large industrial integrators
- More than 600 participating entities in Clean Sky 1

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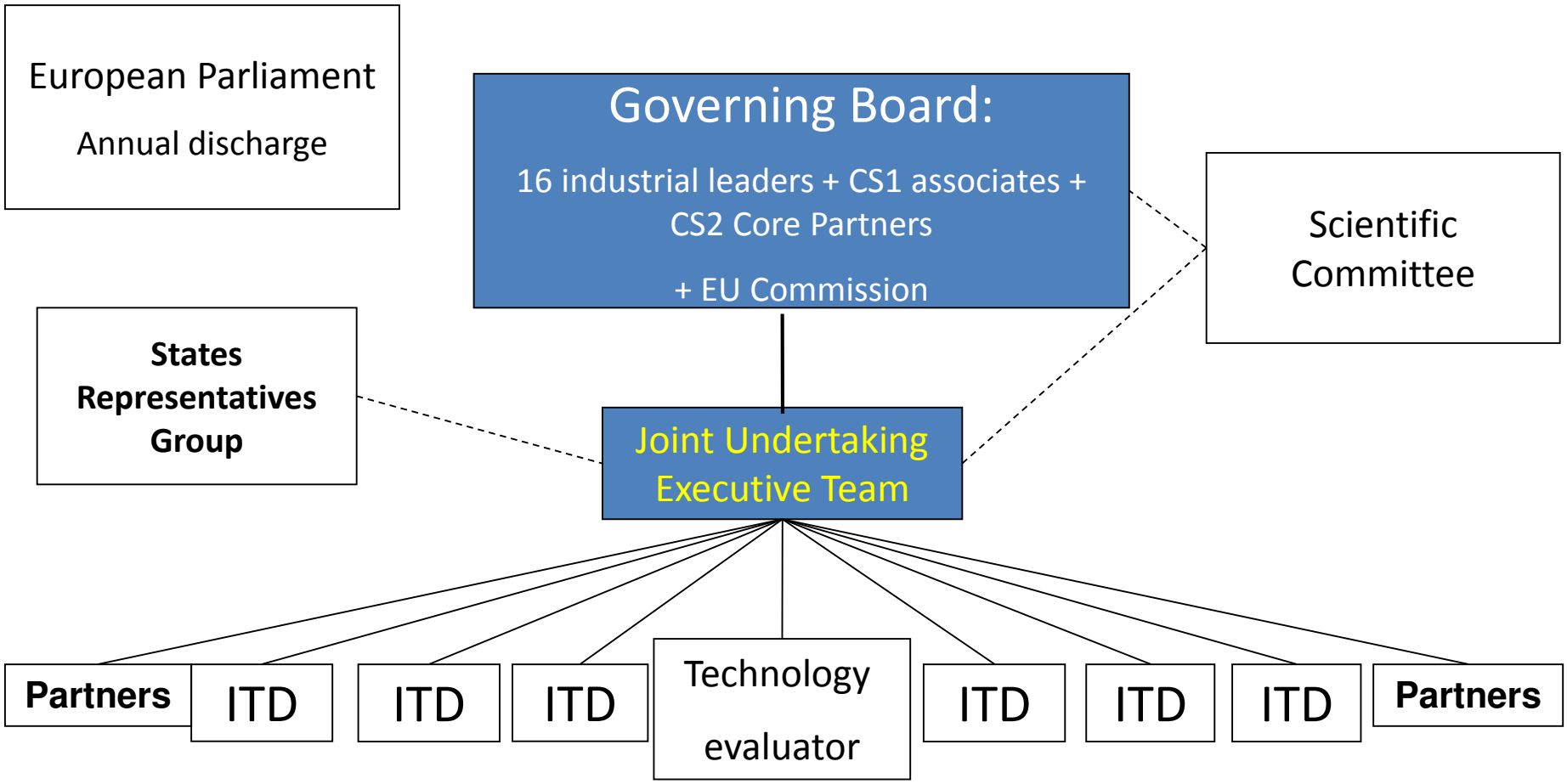
Governance and organisation



ITD: integrated Technology Demonstrator = technological platforms

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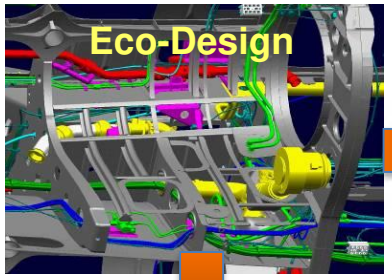
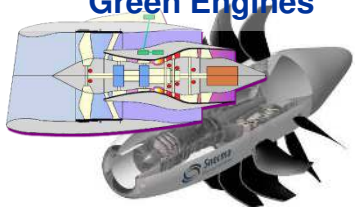
Clean Sky 1, an integrated programme structure

Evaluateur technologique (gains CO2 et bruit résultants – obj 20 à 30%)

avions virtuels (modèles)



Sustainable and Green Engines



TECHNOLOGIES & DEMONSTRATEURS

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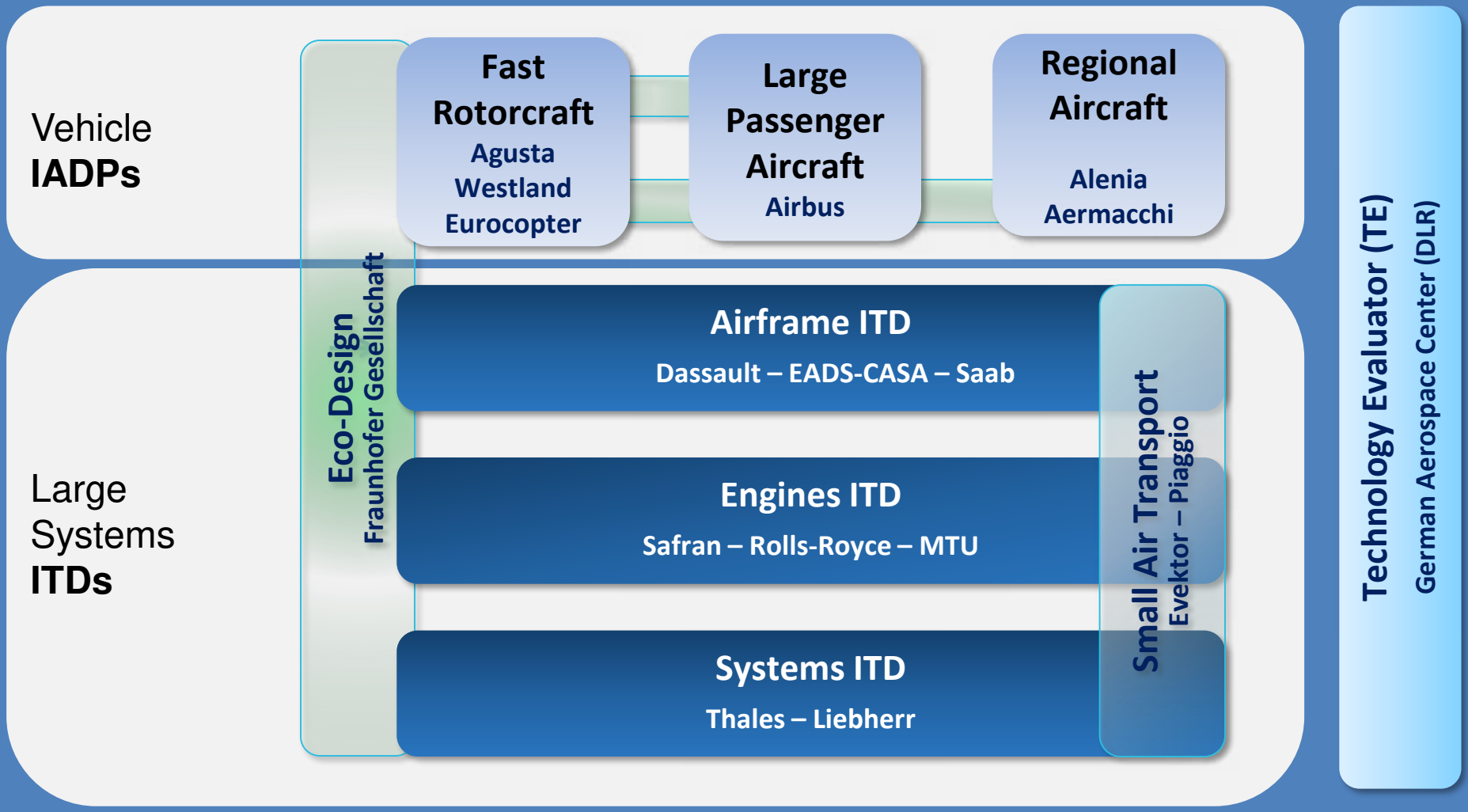
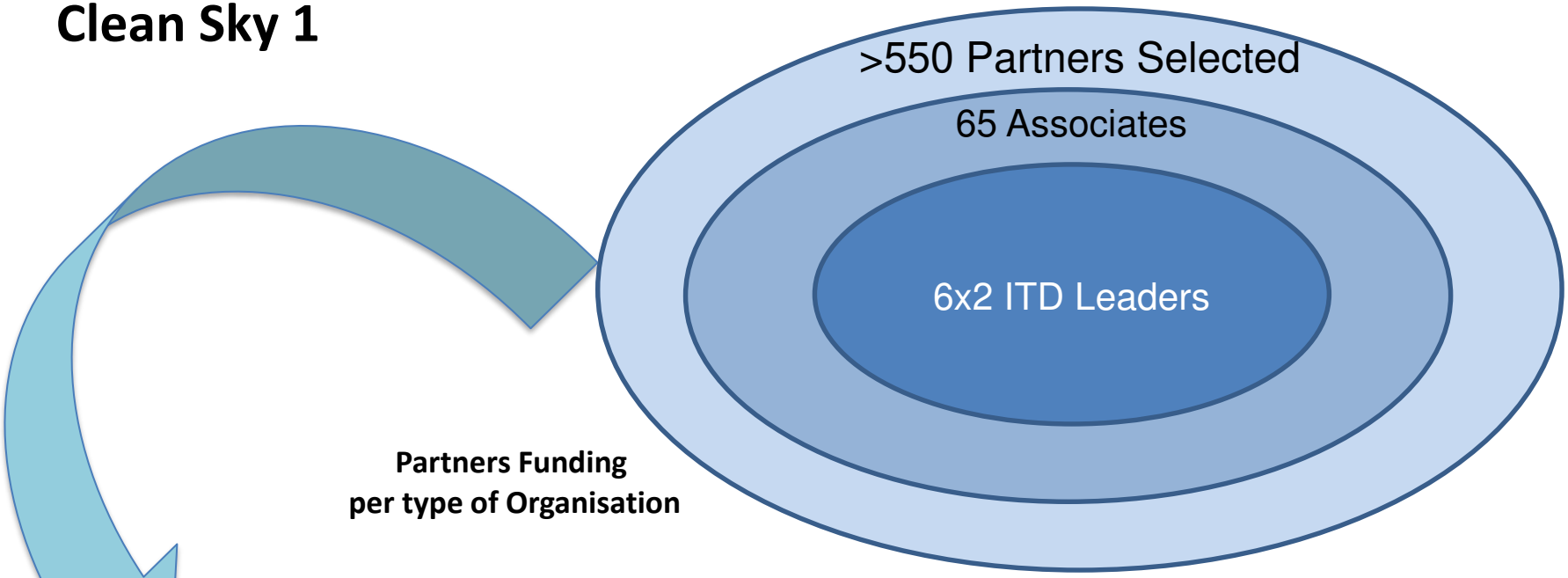
Organisation du programme Clean Sky 2

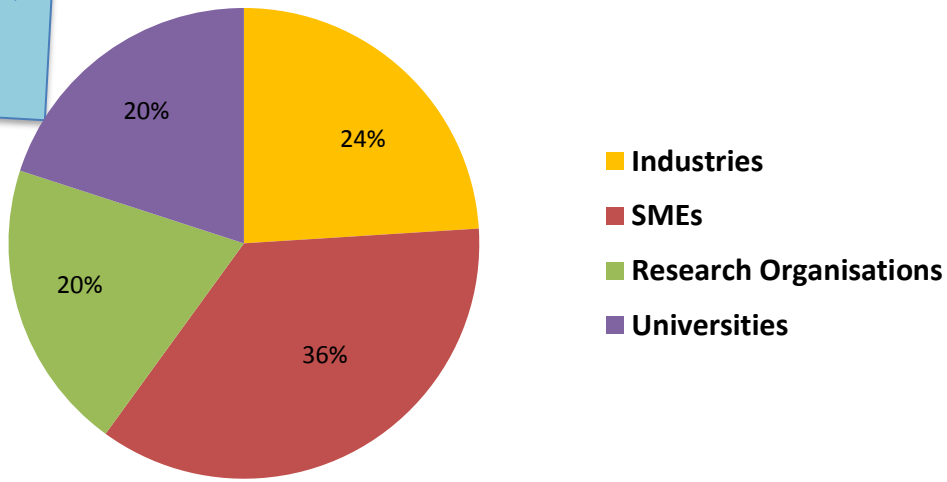


Clean Sky: Broad and Open Participation

Clean Sky 1



Partners Funding per type of Organisation



CS2: 16 leaders
Déjà 75 “Core Partners”
(=Associés)

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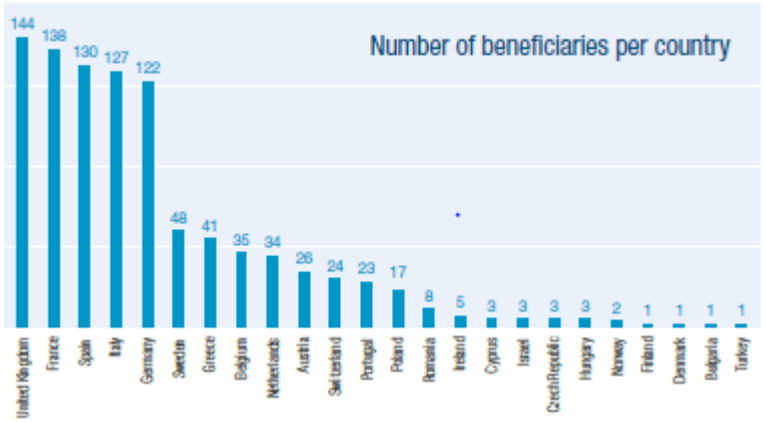
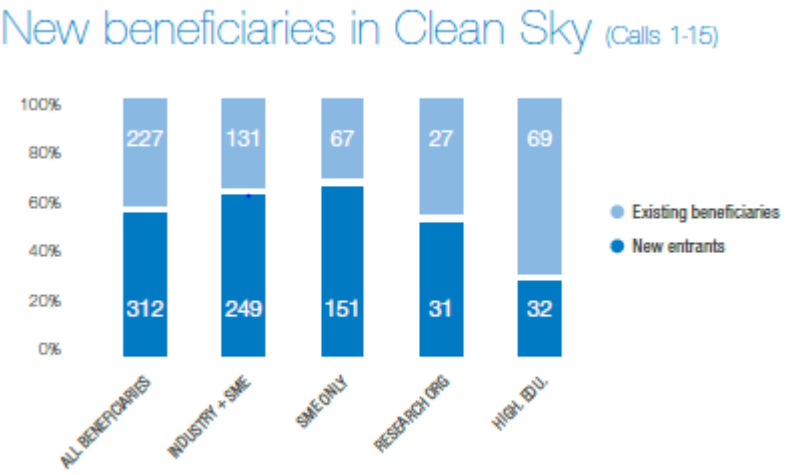
Clean Sky 1 Calls: a wide distribution throughout Europe
A majority of newcomers



24 States

Majority of newcomers in EU research



Summary: main areas – strategic focus
For Clean Sky 1 & 2

Clean Sky 1

Environment, for:

- Short/medium range a/c
- Long range (engine only)
- Regional, turboprop
- Light/medium rotorcraft
- Business jets

Clean Sky 2 additions

Environment and competitiveness, for:

- Same as above, +
- Long range
- High-speed rotorcraft
- General aviation < 20 pax

Architectures
- Rear-mounted engines (OR)
- Integrated cabin/cargo design
- Distributed propulsion

Flight physics
- Laminarity
- Load control – morphing wing
- Noise reduction and shielding

Materials / structures
- Composites for regional a/c
- **Enabling** structures for laminarity, etc
- Manufacturing & maintenance

Propulsion
- Geared configurations / high bypass
- Electrical and hybrid

Cabin
- Bleedless configurations

On-board energy
- Green taxiing
- Elec. Wing

FMS
- Trajectory optimisation
- Cockpit

Clean Sky 1: satisfactory environmental results…

Product	Wide-body	Narrow-body	Regional	Corporate	Rotorcraft
Results from the 2015 TE assessment	CO2 -19%	CO2 -40%	CO2 -20%	CO2 -33%	CO2 -10 to -20%
	Noise** -79%	Noise -55%	Noise -40%	Noise -58%	Noise -20 to -25%

… which will be concretized when, and only when, Clean Sky technologies are included in commercial products

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Some examples of Calls for Proposals topics

Effect of tolerance variation in high power density gears
Non-intrusive Turbine Blade measurements
Instrumentation Capability for Accelerated Lean Burn development
Advanced methods for prediction of lean burn combustor unsteady phenomena
Design methods for accurate combustor wall temperature
MEMS Accelerometer – Miniaturisation of the analog electronics in ASIC(s)
Miniaturization of digital processing function for a MEMS pendulous accelerometer
In-service monitoring of Leading Edge Contamination and Damage
In-Flight Local Surface Deformation Measurements by Means of Reflectometry and Shadow Casting
Optimizing power density of aircraft inverter by combining topology and PWM-patterns
Development of carbon nanotubes doped composite part
Design of locally reactive acoustic material for turbomachinery active noise control
Production of yarns and fabrics based on recycled carbon fibres (CFs)

"CfP" projects are contributing to demonstrators, but their own, internal content must be considered also for their own, intrinsic outcomes

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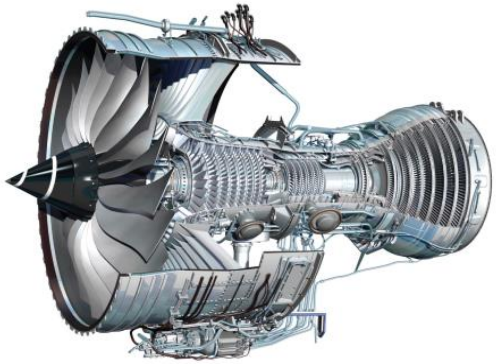
4 Engine demonstrators tested

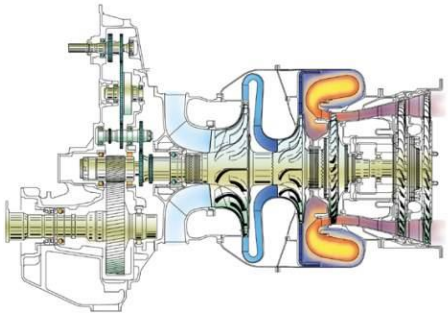


Large 3-shaft engine
Advanced Low Pressure Spool

Flight tests in progress started mid-2014

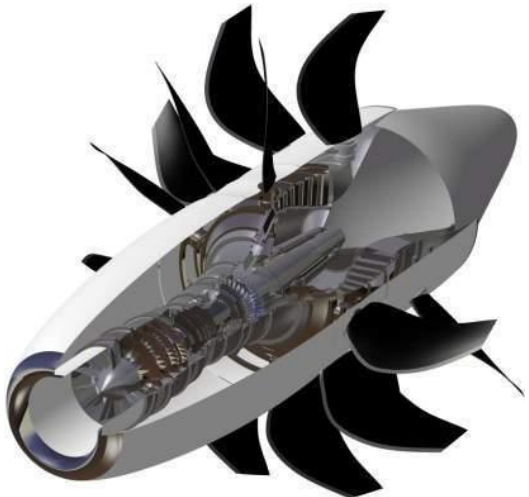
HPC and LPT modules for geared turbofan*+ new gearbox*

Tests completed Nov 2015



Advanced turboshaft, 2000 hp
Fuel efficiency and Nox

Tests completed
New Product emerging from technology development: ARRANO, selected for new H160 helicopter



Contra-rotating Open Rotor

Ground tests scheduled September 2016

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Clean Sky 2: Engines, one out of 7 full projects

Very High Bypass Ration [VHBR] Architectures

Underlying technologies for VHBR engines with focus on the "Middle-of-Market" short range aircraft

Composites

Integration

Turbines

Transmissions

Externals & Structures

Control & Power Systems

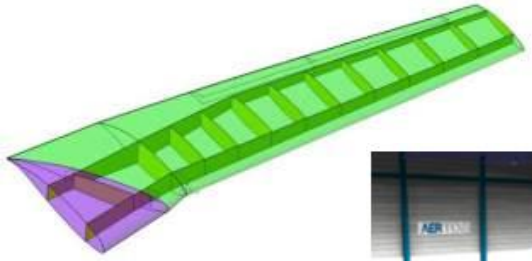
VHBR technologies for the long range airliner market with Engine Demonstrator

Laminarity: The BLADE Project
Demonstrating an INDUSTRIAL feasibility

A340 flight test platform: Integration started in Tarbes

Natural Laminar Flow Wing

- Proof of natural laminar wing concept by WT testing
- Use of novel materials and structural concepts
- Large scale flight test demonstration of the laminar wing



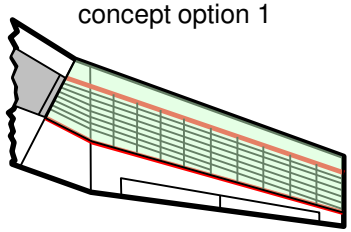
Laminar Wing Ground test demonstrator to address structural, system and manufacturing aspects

Smart Wing semi-assembly ground transportation (Aernnova)

Current manufacturing of the Smart Wing integrated upper panel (SAAB)

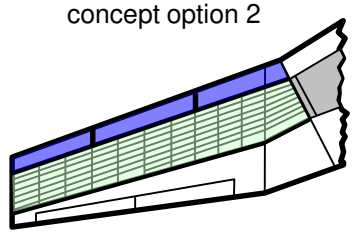
Starboard wing

Laminar wing structure concept option 1



Port wing

Laminar wing structure concept option 2



Laminar Wing aerodynamic layout and performance

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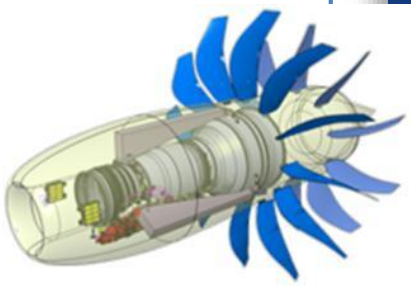
Clean Sky 2: Large Passenger Aircraft



Large Passenger Aircraft Platform – Integration Topics

„Platform 1 - OAD“

vanced Engine and Aircraft Configurations

„Platform 2 - OPD“

Innovative Physical Integration Cabin-System-Structure

„Platform 3 - OSD“

Next Gen. Electrical A/C Systems, Cockpit Systems & Avionics

Platform 1 Advanced Engine and Aircraft Configurations

Open Rotor demo in flight

Advanced engine integration driven rear fuselage

Validation of dynamically scaled flight testing

Hybrid laminar flow control large scale demonstration

Hybrid propulsion

Platform 2 Innovative Physical Integration Cabin-System-Structure

Integrated product architecture

Pre-Production Line Technologies

Platform 3 Next Gen. Electrical Aircraft A/C Systems, Cockpits & Avionics

Enhanced flight operations and functions

Avionic backbone technologies development and integration

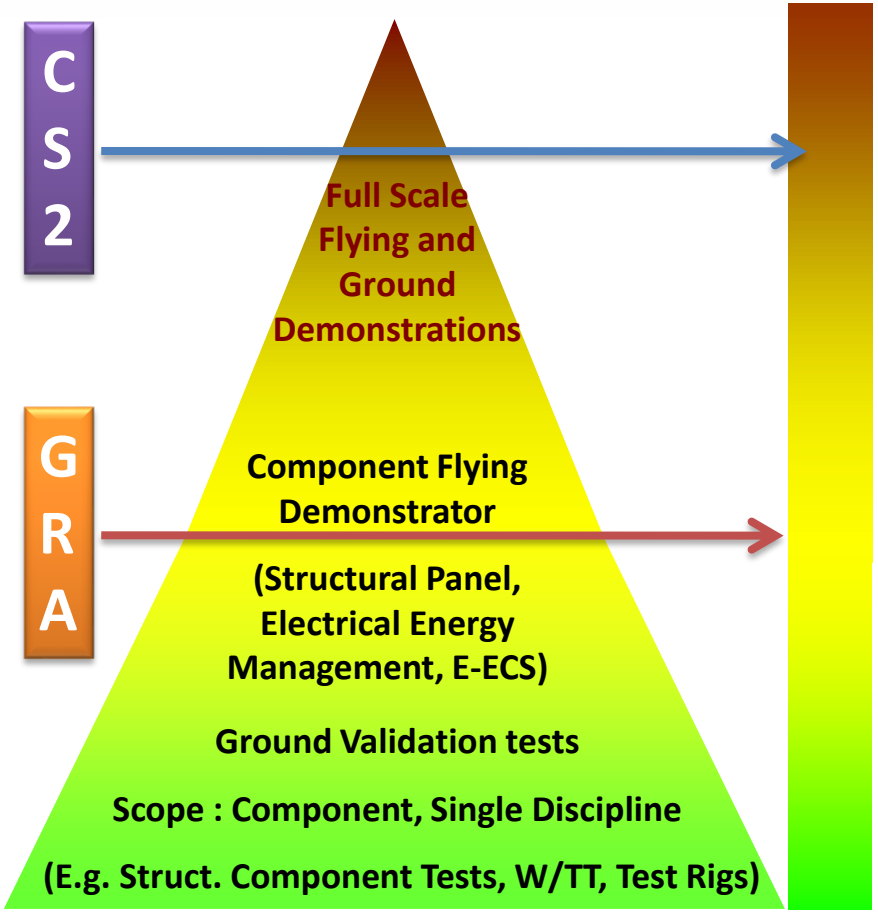
Next generation cockpit ground demonstrator

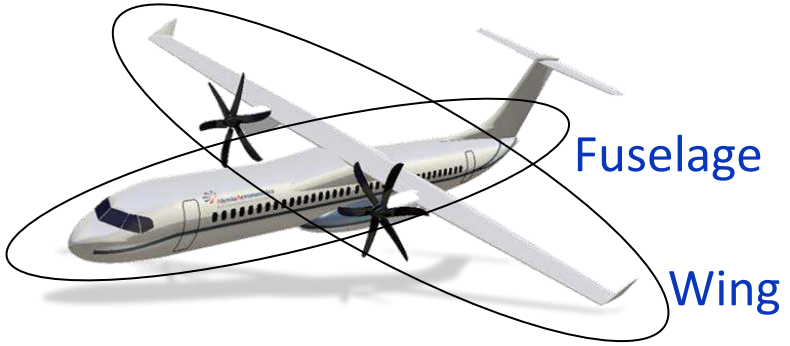
Next generation cockpit features flight demonstration

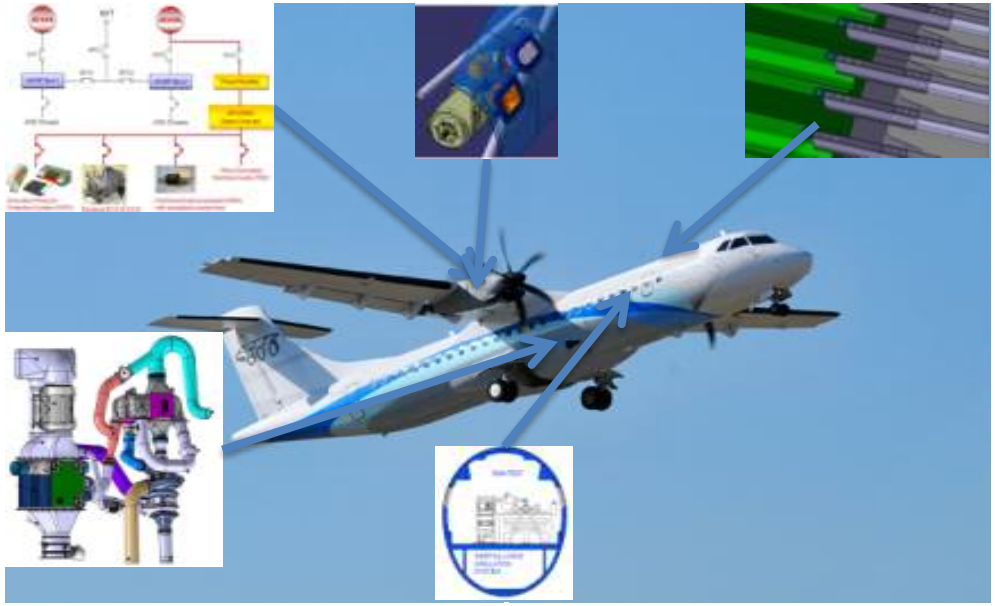
“Pilot case” demonstrators

Regional Aircraft
From *Clean Sky 1* to *Clean Sky 2*

High Integration of Technologies at Aircraft Level







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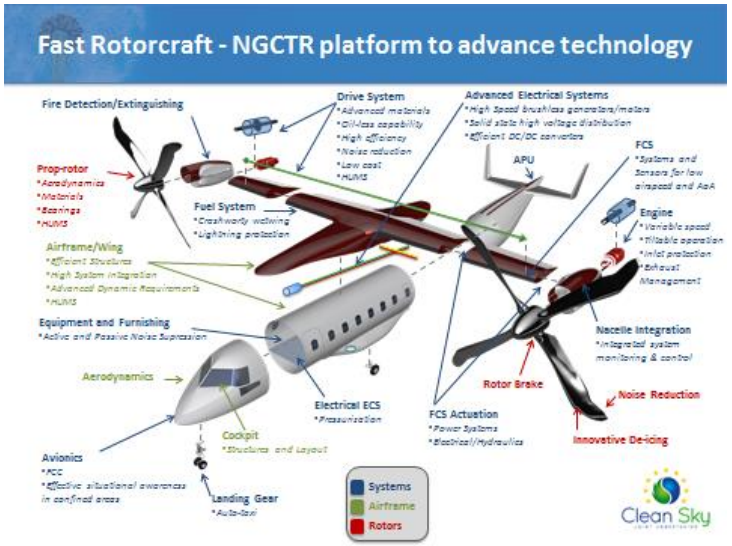
Fast Rotorcraft



Tilt-rotor

Compound

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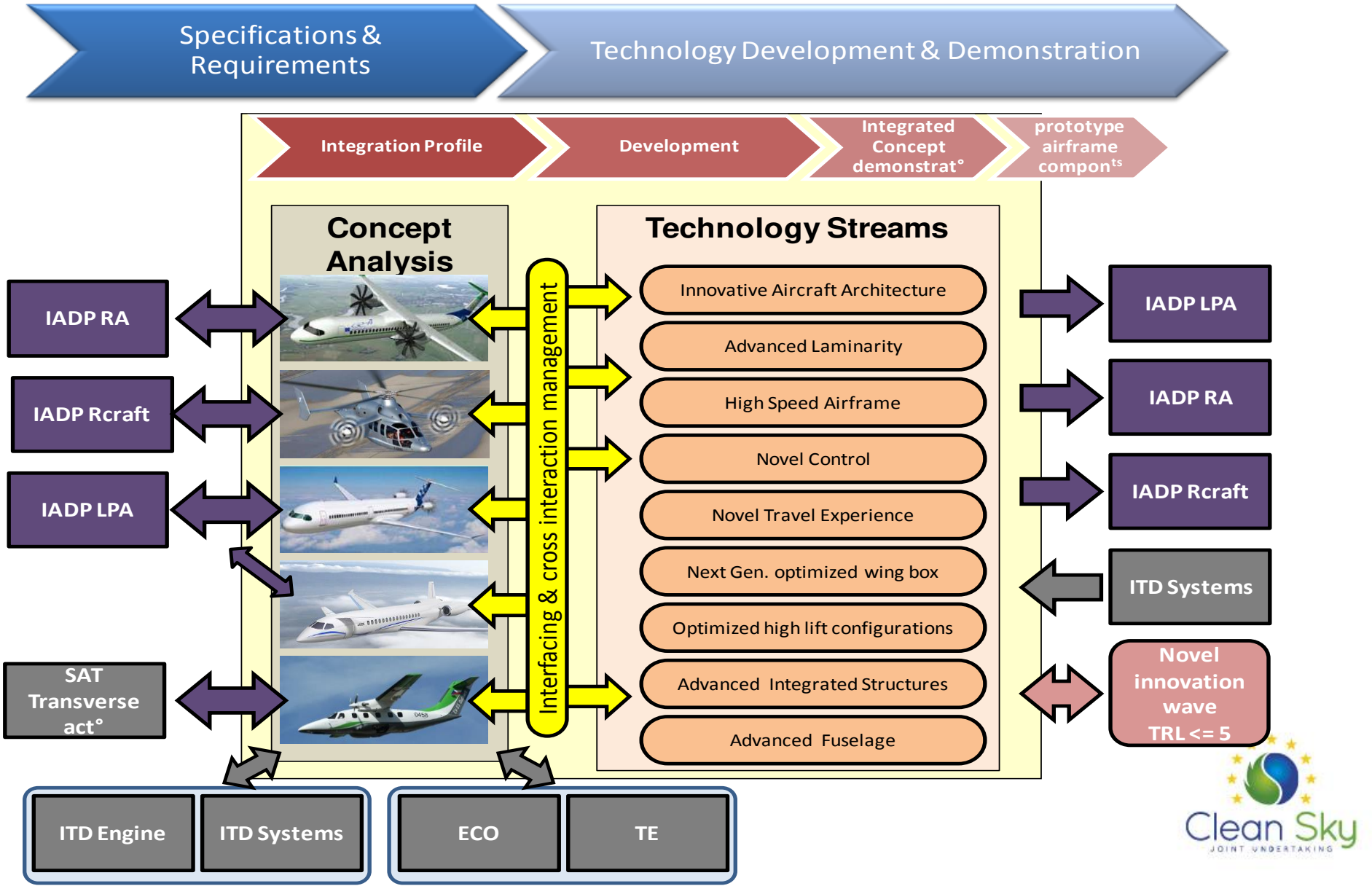
Airframe ITD
Overall Integration Approach



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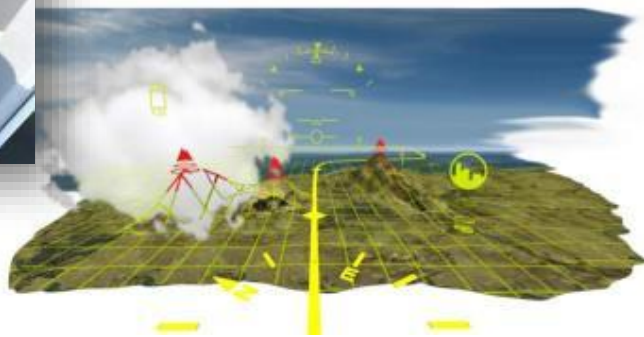
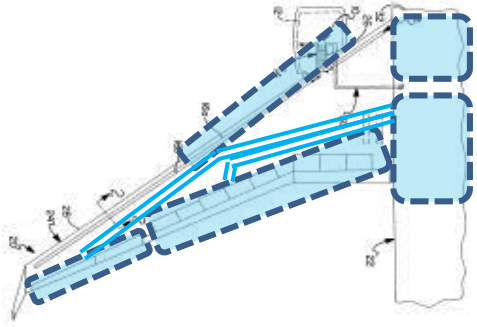
Systems ITD main demonstrations (1/2)

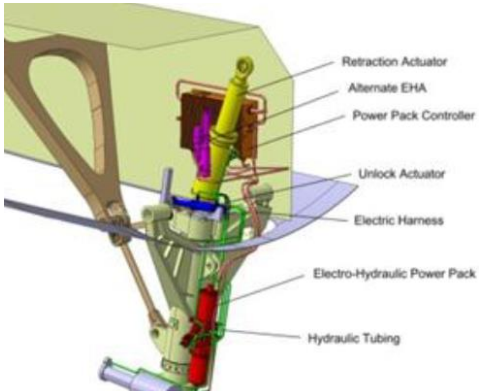
Integrated Cockpit

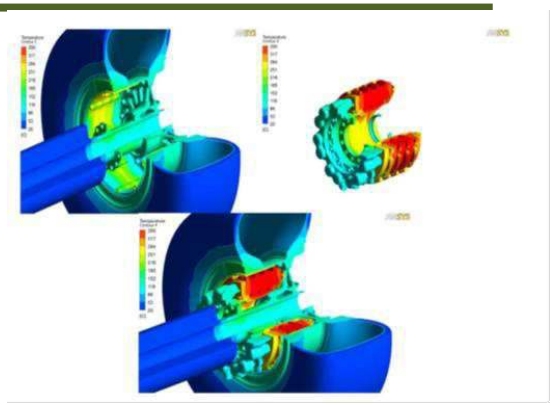




Innovative Electrical Wing

Landing Gears Systems





Clean Sky
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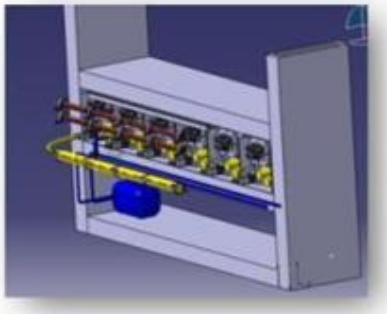
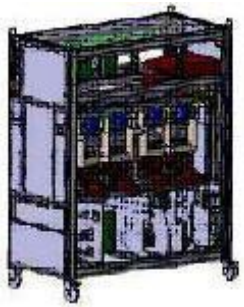
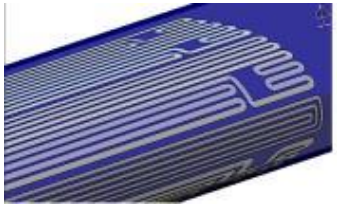
Systems ITD main demonstrations (2/2)

Power Generation
&
Distribution







Major Loads

Systems for Small Air Transport

Cabin and Cargo

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Scenarios – exploiting the results

New Product Timeline Assumptions for Clean Sky 2 Economic Case: Illustrative only

New Narrowbodies

2 new platforms entering into service around 2025 – 2030, 2 new engine programmes

New Rotorcraft

2 new platforms entering into service between 2020 & 2030, new engine and systems programmes

2020 | 2025 | 2030 | 2035 | 2040 | 2045

New Regional & Business Jets

Significant new European vehicles entering into service between 2020-2035, new engine and systems programmes

New Widebodies

2 new platforms entering into service between 2030 - 2035, 1 new European engine programme

Synergies between Clean Sky and Structural Funds

- ✓ *Combination of funding under H2020 and ESIF is now allowed and encouraged under H2020 (Article 31 of RfP) and the "Common Strategic Framework" of ESIF;* ***included in Clean Sky 2 Regulation***

- ✓ JTIs can be instrumental for underpinning RIS3 and stimulating credible and coordinated R&I investments

- ✓ Aeronautics is one of the best sectors of excellence in Europe in a globally growing demand (5% per year), i.e. return on public (regional) investment in innovation, *geared to the right strategic targets*, may be high

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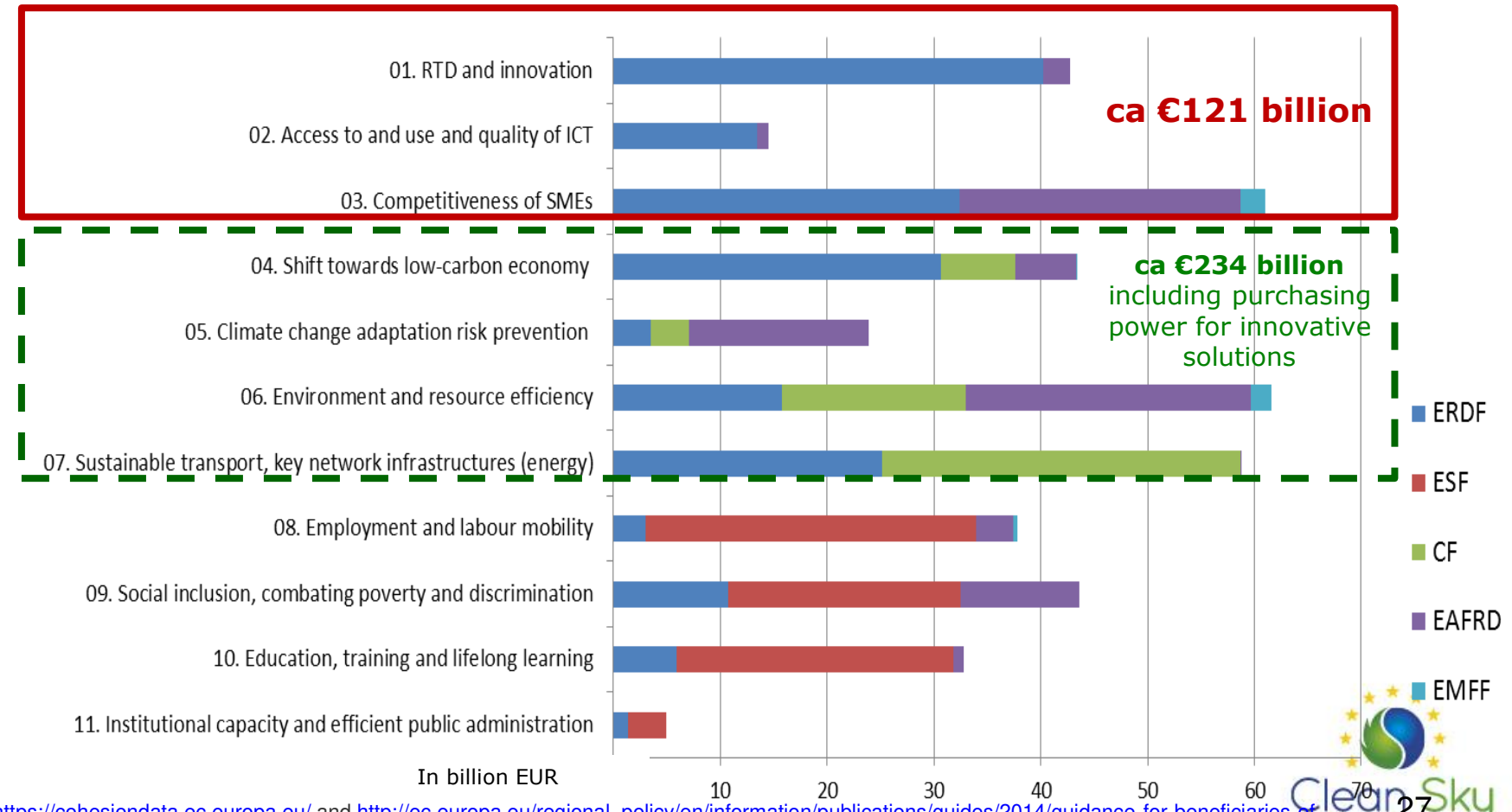
Smart Specialisation

= **Integrated agenda for place-based economic transformation in an outward looking perspective,** strengthening RTD innovation, with a focus of efforts on **what a region/MS is best in** and the emergence of new competitive industries in new niches and value chains and with a structural longer term impact

- ✓ Based on **SWOT** or similar **analysis**
- ✓ Concentrate resources on a **limited** set of priorities
- ✓ Encourages **private** investment in RTD (policy mix)
- ✓ **Monitoring** system
- ✓ **multi-annual plan for budgeting**

- ➢ Developed via an **Entrepreneurial Discovery Process**

Thematic Concentration of ESIF

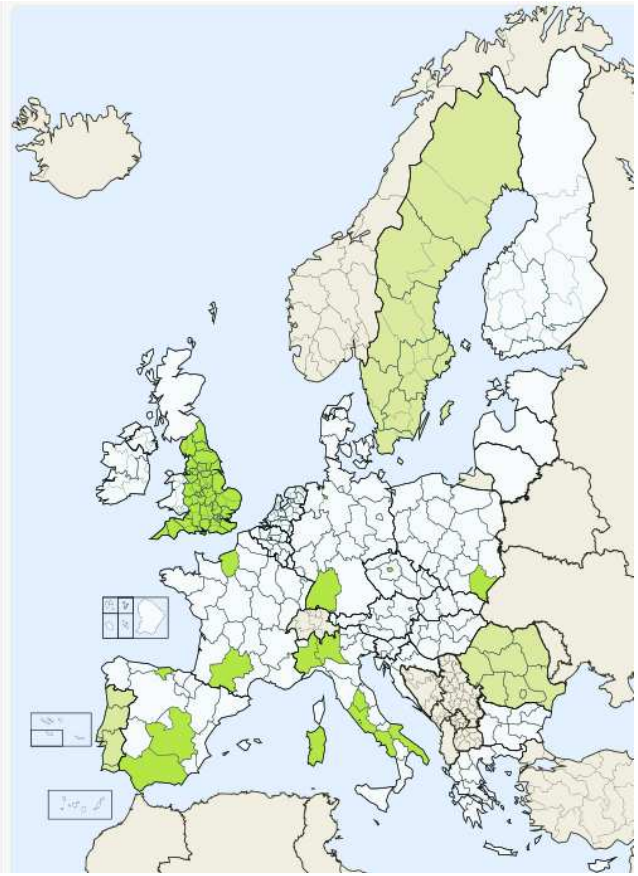


Source: https://cohesiondata.ec.europa.eu/ and http://ec.europa.eu/regional_policy/en/information/publications/guides/2014/guidance-for-beneficiaries-of-european-structural-and-investment-funds-and-related-eu-instruments

Clean Sky action on Synergies with ESIF

- A “Clean Sky label” will have an incentive effect and “guarantee of success” for MS/Regions to invest on projects, support actions, infrastructures, facilities in favour of well performed/running actions

- a “win-win” strategy for policy makers to direct R&I regional funds toward a credible, global RIS3 strategy: think global, act local



- Focus: Regions with aerospace specialisations, or transverse disciplines like materials or embedded systems

Clean Sky
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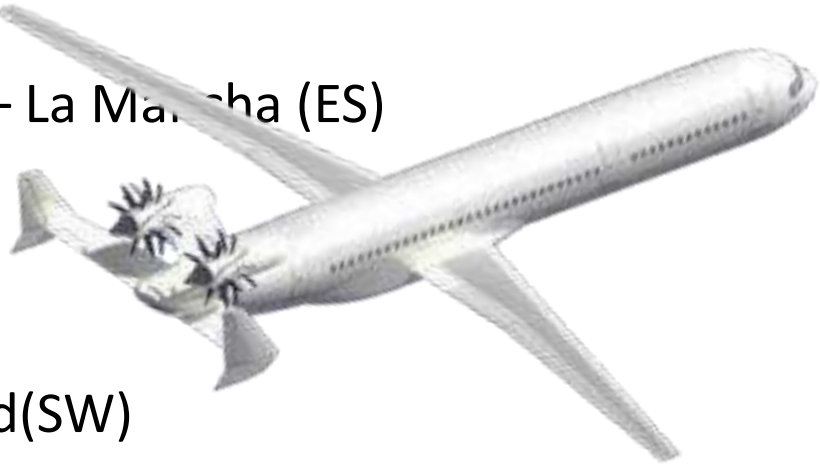
A concrete, pragmatic approach

- Clean Sky at the forefront of H2020/ESIF synergies:

11 MoU **signed** with

  - Midi-Pyrénées (FR)
  - Andalusia, Catalonia and Castilla – La Mancha (ES)
  - Romania (state level)
  - Campania (IT)
  - Flevoland and Zuid Holland (NL)
  - Ostergötland and Vastra Götaland(SW)
  - Czech Republic (State level)



- Several scenarios proposed by JU to Regions for **complementary** fundings within the existing rules and processes
- Call for projects **launched** by Midi-Pyrénées according to scenario 4 (themes co-defined with Clean Sky JU)
- 2 Clean Sky – related projects selected by Catalonia

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What Clean Sky intends to demonstrate by 2017
(final assessment of CS1, mid-term H2020)

- An ambitious / effective / consistent / far-looking / stable / flexible programme
- Focused on the right priorities for environment, mobility and competitiveness
- Transparent and well understood by all political decision makers
- Playing the role of flagship for all EU aero research – strongly contributing to an overall consistency
- Leveraging and including lower-TRL activities thanks to the mainstream of demonstrators
- Open to bottom-up approaches
- An “Undertaking” where all stakeholders find themselves at home and consider as their optimal instrument for R&I: Industry-led… but fostering wide SME, RE and Academia participation

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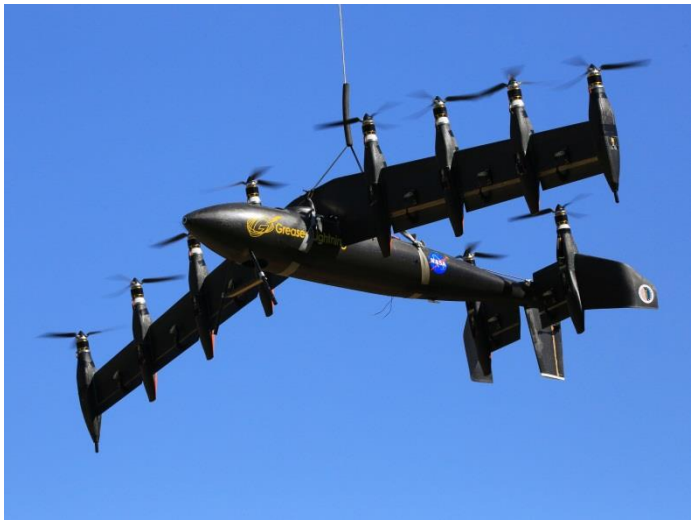
Next flagships for EU aeronautics? How innovative?



NASA 10-engine electric plane scaled test plane

Besides the (demanding and cutting-edge) “usual” research,
for attracting new generations, stimulating research, feeding back the whole system,
the EU needs some far-reaching, attractive, revolutionary, risky… but *concrete* symbols

What will these symbols be tomorrow?

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