



Clean Sky JT Systems for green operation

Version of 1 June 2006

Clean Sky : ACARE “green goals”

ACARE goals

**Reduced
Fuel Consumption
(CO₂ & NOx reduction)**



**External noise
reduction**



**« Ecolonomic »
life cycle**



Technology Domains

- **Engines**
- **Loads & Flow Control**
- **New Aircraft Configurations**
- **Low Weight Configurations**
- **Aircraft Energy Management**
- **Mission Management**

- **Engines**
- **Trajectory Management**
- **New Aircraft Configurations**
- **Low noise Configurations**
- **Rotorcraft Noise Reduction**
- **Rotorcraft optimised configuration**

- **Aircraft Life Cycle**

Systems for green operation : Rationale

- Up to now, aircrafts systems mainly designed from safety and affordability view point
- Need for new systems approaches to integrate social demand to reduce emissions, noise and fuel consumption for green operation
- Two main systems domains identified as major contributors to green and affordable challenge :
 - | *The Management of Aircraft Energy*
 - | *The Management of Trajectories and Mission*

Systems for green operation : Concepts

Management of Aircraft Energy

- The use of **all-electric equipment** system architectures will allow a more fuel-efficient use of secondary power, from electrical generation and distribution to electrical aircraft systems.
- **Thermal management** will address many levels, particularly relating to electric aircraft, from hot spots in large power electronics, to motor drive system cooling, to overall aircraft solutions.



Management of Trajectory and Mission



- Systems and procedures will be designed to perform high precision **green trajectories** optimised to minimise noise and emissions impact in airport areas.
 - New aircraft systems for **smart ground operations** will optimise use of engine power when aircraft are on ground such as providing reduced emission taxiing capabilities.
 - Aircraft will be able to fly **green missions** from start to finish, thanks to technologies which allow to avoid fuel consuming meteorological hazards and to adapt flight path to known local conditions.
- Ground based test rigs, as well as flight testing, will be used to validate these concepts and technologies

Main contributors for green operation

		Fuel consumption and emissions reduction	External noise reduction
Management of Aircraft Energy	All-electric aircraft equipment	Main contribution	
	Thermal management	Main contribution	
Management of Trajectory and Mission	Green trajectories	Contribution	Main contribution
	Smart ground operations	Main contribution	Contribution
	Green mission	Main contribution	Contribution



Clean Sky JT Systems for green operation

Content

Management of Aircraft Energy

All-electric aircraft equipment system architectures

§ Objective:

- § To facilitate the all-electric aircraft, which leads to new possibilities in reducing aircraft emissions through lower fuel consumption

§ Concepts :

- § Electrical Power generation technologies and use in alternative architectures
- § Electrical Power distribution architectures and technologies
- § Electrical users in new architectures

Management of Aircraft Energy

- § In order to provide maximum benefit to the JTI, the most important aircraft functions will be selected for technology solutions. These will be chosen dependent on their:
 - § Ability to address the JTI goals
 - § Implications for aircraft safety and certification
- § **Aircraft functions which may be addressed by using Equipment Systems**
 - § Cabin and aircraft pressurisation
 - § Aircraft thermal management
 - § Flight control
 - § Ice and rain protection
 - § Take-off, landing, taxiing and braking (landing gear)
 - § Primary power (mechanical, electrical, hydraulic and pneumatic) generation and distribution
 - § Auxiliary and emergency energy/power generation and storage
 - § Aircraft fuel distribution
 - § Engine support

Management of Aircraft Energy

Thermal Management

§ Objective:

- § Reduce energy losses and optimise the use of heat and cold sources on board and aircraft

§ Concepts :

- § Micromanagement of cooling at local hot spots, especially on new high-power electronics
- § Thermal management of electrical drive systems (most users)
- § Overall thermal management at aircraft level, including novel thermal management architectures for more electric aircraft
- § Use of various cooling technologies (conductive and convective) at each level

Management of Trajectories and Mission

Green Trajectories

§ Objective :

§ Design aircraft systems to achieve excellent dynamic capability to fully exploit its intrinsic performance in following new specific trajectories and associated procedures in all conditions, mainly in the airport vicinity

§ Requirement :

§ Capability to perform high precision optimised trajectories and procedures to minimise noise and emissions impact in given areas, in maintaining robust noise and emissions abatement in presence of perturbations

§ Result :

§ “Green trajectories” based on more precise, reliable and predictable ground flight path, optimised for minimum noise and emissions impact

Management of Trajectories and Mission

Smart Ground Operations

§ Objective :

- § To design aircraft systems to optimise use of engine power when aircraft on ground

§ Requirement :

- § Silent and fuel-efficient taxiing capabilities

§ Result :

- § Use of the landing gear system as a motoring system on ground, so as to allow airplane engines to idle back during taxi, with the expected double benefit of reducing ground noise and reducing fuel burn

Management of Trajectories and Mission

Green Mission

§ Objective :

- § Design aircraft systems to exploit its intrinsic performance to minimise environmental impact all along the mission, in any combination of environmental constraints and in normal and degraded flight conditions

§ Requirement :

- § Capability for multi-criteria flight management optimisation

§ Result :

- § Optimisation of climb, cruise and descent profiles, based on new aircraft performances database which includes environmental parameters and allows multi-criteria optimisation (noise, emissions, fuel, time)
- § Management of any hazard e.g. : weather conditions, traffic change

Overall Programme Timescale

Clean Sky JTI – Systems for green operation, 1 June 2006

