ENVIRONMENTAL SUSTAINABILITY IN THE EUROPEAN SPACE AGENCY

NASA Green Engineering Masters Forum

Presentation of 1 October 2009

By Nathalie MEUSY

Head of the Coordination Office on Sustainable Development, ESA HQ, Directorate of Resources Management and Industrial Matters

Introduction and plan

- **Some basics about ESA**

- **Sustainable Development at ESA**

    - **Background information prior to the creation of the ESA Coordination Office on Sustainable Development**
    - **Progress report of the Office and on-going actions in relation with sustainability within ESA.**

- **Conclusions. Questions and answers.**

THE EUROPEAN SPACE AGENCY

September 2009

European Space Agency

"To provide for and promote, for exclusively peaceful purposes, cooperation among European states in **space research** and **technology** and their **space applications.**"
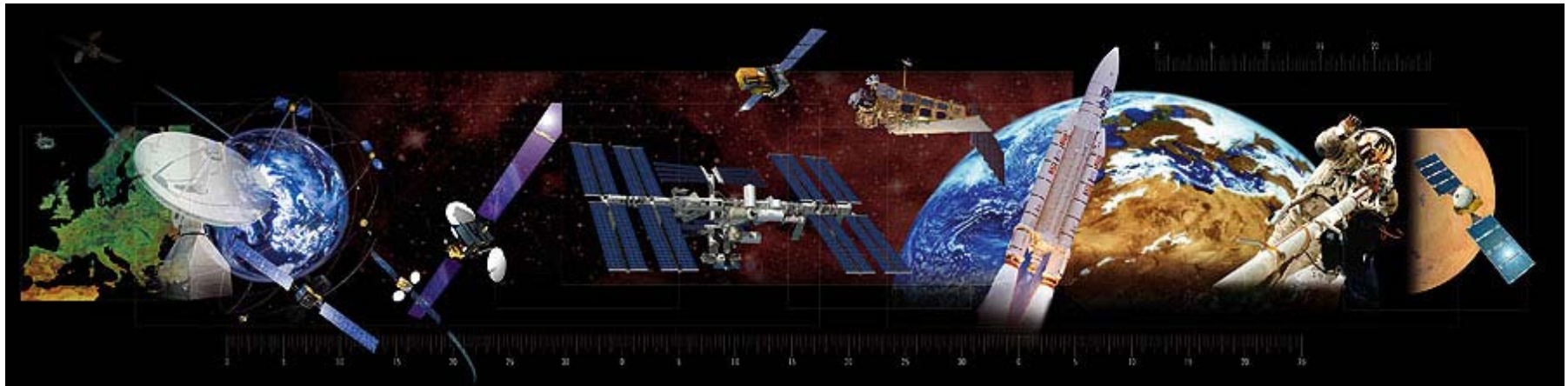
**Article 2 of
ESA Convention**

18 MEMBER STATES

– Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Norway, the Netherlands, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

– Canada takes part in some projects under a cooperation agreement.

– Hungary, Romania and Poland are European Cooperating States.

– Estonia and Slovenia have recently signed cooperation agreements with ESA.

ACTIVITIES

esa

ESA is one of the few space agencies in the world to combine responsibility in all areas of space activity.
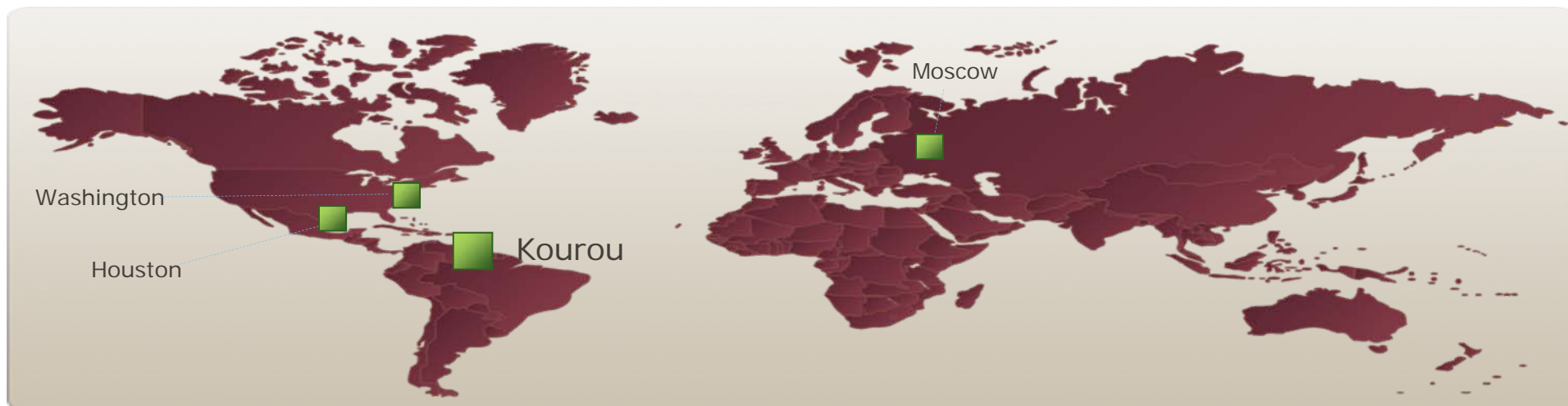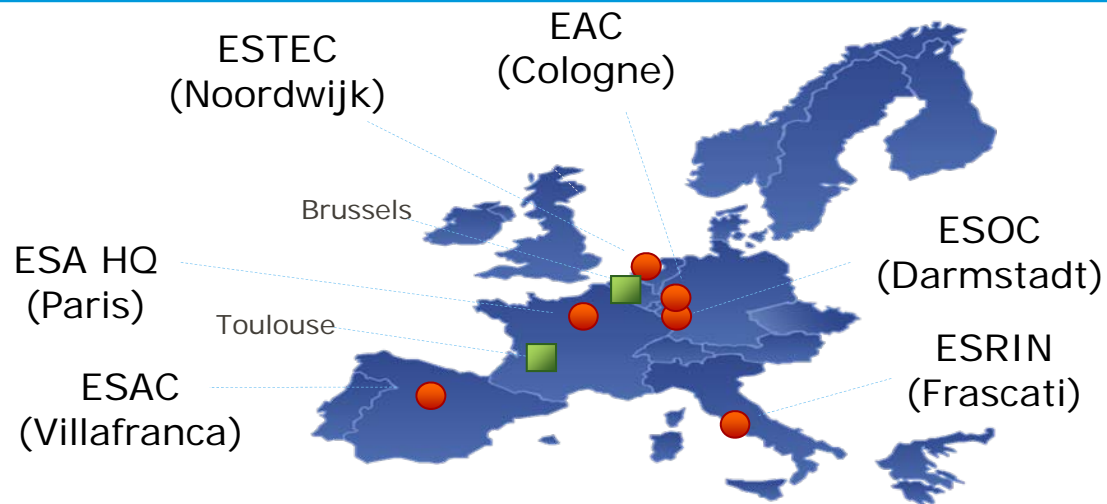
- – Space science
- – Human spaceflight
- – Exploration
- – Earth observation
- – Launchers
- – Navigation
- – Telecommunications
- – Technology
- – Operations

ESA'S LOCATIONS

Establishments & Centres

Offices

ESTEC
(Noordwijk)

EAC
(Cologne)

Brussels

ESOC
(Darmstadt)

ESA HQ
(Paris)

Toulouse

ESRIN
(Frascati)

ESAC
(Villafranca)

Moscow

Washington

Houston

Kourou

ESA FACTS AND FIGURES

- Over 30 years of experience

- 18 Member States

- Six establishments, 2043 staff

- 3 500 million Euro budget (2009)

- Over 60 satellites designed and

 tested

- 14 scientific satellites in operation

- Five types of launcher developed

- More than 180 launches made

Some basics about ESA/ Governance structure
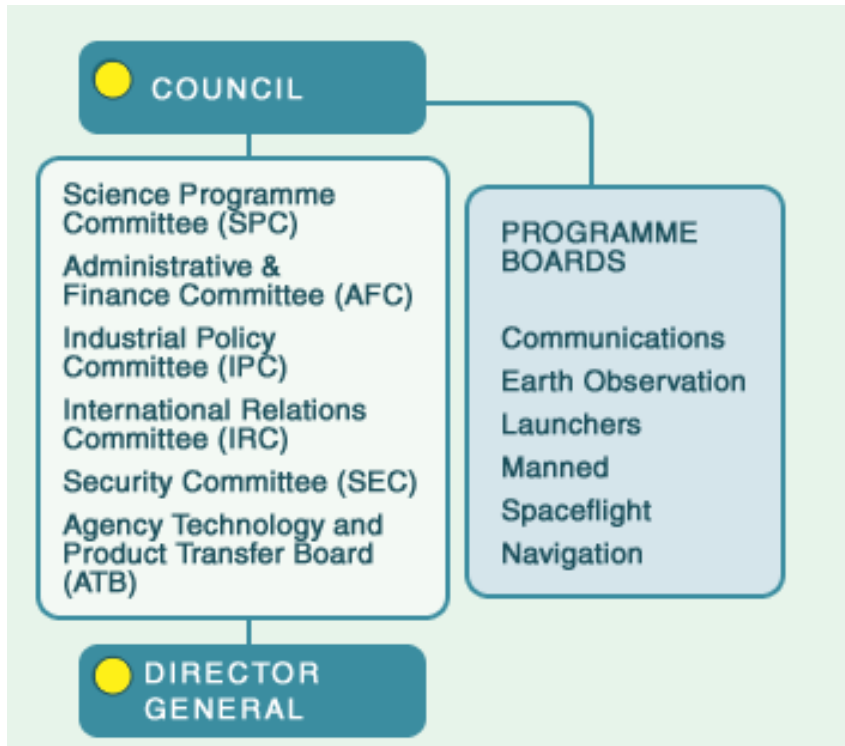
Council: Composed of representatives of the member states (delegates), it is the governing body of the Agency. The Council makes decisions on:
○ programs
○ finance
○ industrial policy

Director General: Appointed by the Council. He is the chief executive officer of the Agency and its legal representative.

Some basics about ESA/ Internal structure

Vertical directorates related to ESA programs
- D/EOP   Earth Observation
- D/NAV   Galileo Program and Navigation
- D/HSF   Human Spaceflight
- D/LAU   Launchers
- D/SRE   Science and Robotic Exploration
- D/TIA   Telecommunications and Integrated Applications

Horizontal directorates provide functional support to the whole organisation
- D/LEX   Legal Affairs and External Relations
- D/OPS   Operations and Infrastructure
- D/RES   Resources Management and Industrial Matters
- D/TEC   Technical and Quality Management

SUSTAINABLE DEVELOPMENT AT ESA

- Although Sustainable Development is not new at ESA, it is a new on-going initiative at corp. level

- It is part of the SRM (Sustainable Resources Management) initiative for the **environmental, social/ societal and economic components**.

- As a matter of fact, **Sustainable Development which is the challenge aiming at conciliating ecology and social and economic development,** is **one of the urgent issues facing society at large**.

  - What is at stake is the long-term survival of**:**

    * **all living organisms** (natural, environmental and human species) and also

    * our **social and economic systems.**

- The **current environmental situation worldwide** is the result of 2 main factors: **natural resources depletion and human behaviour impact.**

- As a major actor in society, **any company, any organisation has an important role to play in order to preserve resources of all kinds**, and demonstrates its commitment to Sustainable Development (translated into Corporate Social Responsibility for an organisation), through its strategy and its day-to-day functioning

SUSTAINABLE DEVELOPMENT AT ESA

– As a public international organisation ESA needs to show such a determined commitment both in its internal functioning but also in its core-business activities

– As a space agency, ESA is not always seen in a positive manner; it has sometimes to contend with **a strong negative image,** rightly or wrongly, in the mind of the general public as regards its core-business activities (typical e.g: impact of launches on the atmosphere and ozone layer, debris falling on Earth with potential impact on human population and bio-diversity).

We therefore **need to show that this image does not correspond to reality** and if there are doubts, study and discuss these in full transparency and secondly **emphasise ESA's pro-active role in favour of the environment and sustainability** either directly through its behaviour or indirectly through the use of its programmes (e.g. Earth Observation – climate change, preservation of archeological sites - , Telecommunications – bridging Digital Devide, Telemedicine -, etc)

SUSTAINABLE DEVELOPMENT AT ESA

Since 2007, different actions have been initiated to enlarge our awareness and knowledge with regard to sustainability:

- 2 studies have been launched by the General Studies Programs Office (attached to Director General's Strategy Office):

  - One study on ESA site-operations: in order to obtain the Agency's environmental (incl. carbon) footprint with associated recommandations.

  - Another study on ESA industry and partners: in relation with sustainability of space activities in the context of a growing regulatory framework.

- Staff consultation on Sustainable Development:

  - Citizen's questionnaire

  - Survey/ Call for ideas

Staff consultation: quotations and comments

– **From Citizen questionnaire :**

  – « It is good to raise awareness »

  – « We have to give up our throw away society and recycle products »

  – « I feel a European citizen committed towards SD »

– **From Call for ideas:**

  – The SD issue is 'imperative' 'urgent' 'a good thing'

  – Staff are 'grateful for the initiative' SD federates all staff inside one ESA independently from their nationality, education, profession etc.

  – The initiative of the survey was perceived as 'a real opportunity for at last implementing provisions'

  – « The organisation role must be clarified »

  – « ESA must be exemplary »

  – « ESA must commit itself vis-à-vis the entire society »

  – « It is a top priority responsibility »

External considerations

– European Union is strongly committed toward Sustainable Development in all EU policies :

  – « SD to be integrated into policy-making at all levels ».

  – « Ensure that major policy decisions are based on SD assessment, including cost of inaction »

– For the EU Citizen: increasing awareness and expectations on environment.
  More than 95% of European citizens feel that it is important to protect the environment.

– Sustainability and Environment are on the political agenda at international level

– International standards (GRI –Global Report Initiative- on SD reporting, International Labor Organisation norms on working conditions), initiatives (UN Global Compact principles), certification standards (ISO 14001 on environmental management on site, EMAS, upcoming ISO 26000 on Corporate Social Responsability)

– Industry strong and tangible commitments on SD in all sectors (Information Technology, Transport including Aeronautics, Telecom…)

  – SD policies and actions plans
  – Internal SD organisation structure
  – Annual SD reports
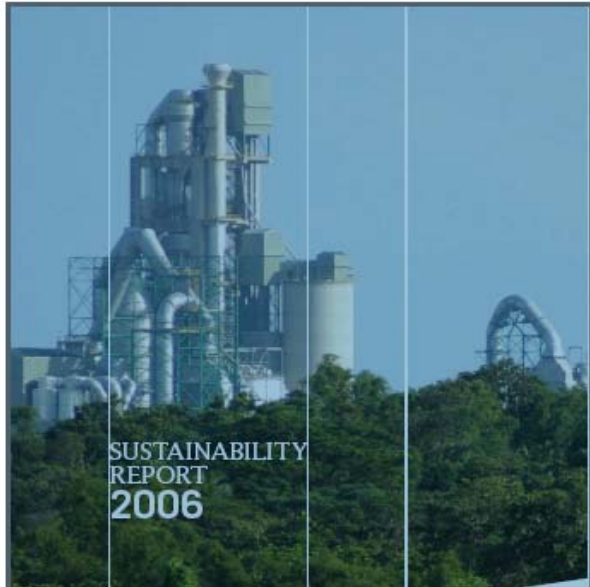
Examples of SD annual reports :

AIR FRANCE KLM
Corporate Social Responsibility Report
2006-07

As the industry leader, it is our responsibility to set a good example. We strive to achieve growth through financial, social and environmental excellence.

Nokia CR Report 2006
Making a human connection

NOKIA
Connecting People

SUSTAINABILITY REPORT 2006

LAFARGE

Corporate Responsibility.
Facts & Figures 2007.

Internal considerations: what are the questions for ESA about Sustainable Development

- To what extent can space activities contribute to the building of a sustainable society?
- How can ESA's own operations be made more sustainable?
- How ESA can influence its stakeholders by a proactive SD policy?
- Agency risks and opportunities in committing or not on SD ?

Go/No-Go for an ESA SD corporate policy ?

« Go- no go » toward SD (1/2) Internal factors

	No go (risks)	Go (opportunities)
Environmental management	Risks of non-conformity Costs of waste of any kind (energy…)	Return on investment (e.g. energy savings) Reduce environmental impact of ESA activities and/or compensate them
Post Staff consultation	Contradiction with signals given through Staff consultation, deception, weakened credibility	Capitalize on an on-going internal dynamic
Internal cohesion and identity at work (« one ESA »)	Pressure/strong expectation for a coherence between the Agency activities and an explicit commitment on SD	Proudness at work, strengthen internal cohesion and identity, new objectives, sharing common goals
Attractiveness for new recruitments	Weaken employer's image	Attract and retain best profiles in particular young generation

	No go (risks)	Go (opportunities)
Relations with Members States, EU and UN	To be bound by drastic and unforeseen norms and obligations Non-conformity with SD international standards and guidelines	Pro-activity positive for image, more autonomy and always good to go beyond compliance Strengthen EU/ESA joint-ventures
Relations with EU Citizens, other stakeholders and NGOs	External stakeholders influence (image, fame…)	Reinforce Agency legitimacy, and image Reinforce the sense of the space dream and adventure
Relations with industry	Risk to weaken leadership and control (most of the time industry is strongly committed on SD),	Strengthen the management and the leadership
Private clients	ESA to be less committed on SD than its clients : bad impact, lack of leadership, gap between SD policies	More competitiveness on the private space market (clients with SD policy)
New innovation fields ESA contribution to a SD society	Role limited to certain ESA programs	Detection of emergent fields, innovation csq of env. regulations strengthen and give more value to existing programs, knowledge sharing and dissemination (edu.)

ESA's SD organisation: the Coordination Office on SD (since November 2008)

- **Why a SD coordination structure?**
    - Need to federate SD existing and future actions inside ESA
    - Need to give more visibility both internally and externally
    - Need to disseminate best knowledge to implement the SD policy
    - Need to define SD criterias, KPIs and review process
    - Need to integrate all these achievements in a comprehensive SD report
- **What are the ESA's SD Coordination Structure missions?**

    A small multi-disciplinary SD structure, located within Directorate of Resources Management, has the following missions:

    1/ the definition of the Agency's SD corporate policy,

    2/ the coordination of all SD aspects (environmental, social, economical) with the support of a network of internal experts from all Directorates (on a geographical and thematic basis) as well as external experts

    3/ the elaboration of the ESA SD annual report.

Who is in the ESA's SD internal network? SD experts chosen:
> On a geographic basis : ESTEC, ESOC, ESRIN…
> On a thematic basis : projects, programs, specific departments and divisions

Who is in the ESA's SD external network?
> SD experts in industry, other space agencies, International organisations, partners in NGOs and other stakeholders
> ➔ For exchanging best practices and having cooperation projects

Progress report of the Coordination Office on SD
and on-going actions in relation with sustainability
within ESA

– The **current actions of the Coordination Office on Sustainable Development** are geared towards these goals:

  – map of existing activities/ professions and assess them against environmental/ social and societal requirements,

  – make a diagnosis of the situation,

  – elaborate a reporting system,

  – issue the first internal SD report and propose a dedicated corporate policy,

  – Issue the first external SD report.

Building the ESA set of SD references and criteria

ESA SD set of references and criteria: for what scope?

Translation of SD international norms into + or- **40 criteria** divided into **5 themes**:

o **ESA's contribution to a sustainable society** (e.g. Earth watch, Global Warming mitigation, bridging digital divide, Space for Africa, Eduspace)

o **Environmental responsibility and management** (e.g. eco-design/ LCA in programs, environmental management on sites and buildings)

o **Human resources and human rights** (e.g. Working conditions, staff representation, non-discrimination, health & safety)

o **Relations with suppliers and partners** (e.g. environmental spec. in calls for tenders, SMEs promotion, Technology Transfer Program)

o **Corporate governance** (ethics issues such as corruption prevention, internal and external controls)

– **Mapping and diagnosis of ESA activities and professions:**

- Mapping:

- Almost 100 interviews took place inside and outside ESA,

- Many documents were scrutinised

- Benchmarking and external contacts were undertaken

- Skeletton of future set of references and criteria (basis for the future SD policy) was designed

- **Diagnosis:**

In the diagnosis, **Activities are seen under 2 perspectives:**

➔ from the core business activities point of view (what is the sustainable part of a Space Agency) and,

➔ from the support activities point of view (how our organisation is environmentally and socially friendly in its working conditions)

SD Progress report and on-going activities in programs and missions

The analysis of the Agency's situation is under a finalisation phase and should be ready for end of November 09. Globallly speaking, the Agency has a rather good level of awareness and actions with regard to Sustainable Development. What is missing is an overall approach comprising a policy and a reporting scheme to be inserted in an annual report. Once the overall picture will be captured, then actions for improvement will have to be planned and financed.

And o**nce the first internal report will be ready and debated, the SD corporate activity should be institutionalised by Member States.**

In parallel of the mapping and diagnosis activities, experts networks and pilot projects have started and actions in programs continue

25
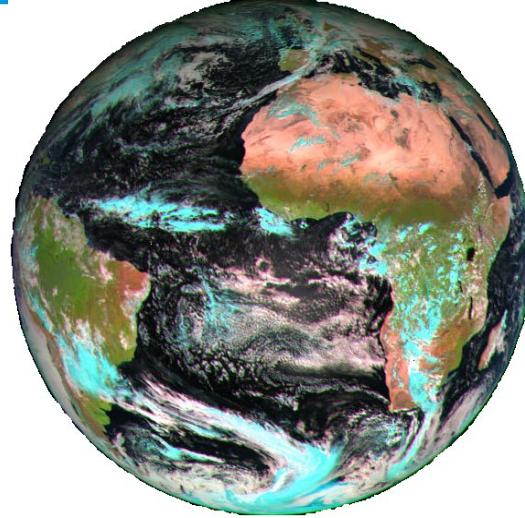
- This pilot project was aiming at assessing at all steps the environmental impact of a space project
- This was performed this year at the Concurrent Design Facility in our technical Centre of the Netherlands, ESTEC, where an additional expert was integrated for the purpose of the experiment into the existing experts team. This new expert was specialised in LCA. Some principles of the cradle-to-cradle philosophy were also considered.

– Result Analysis

  – Data collection during study proved to be the biggest obstacle to completing a comprehensive general overview.

  – R&D activities and traveling have proven to be the most impacting branches in the mission LC.

    – development and re-use of modular and standard components could be beneficial

  – The power subsystem is the more penalizing one.

    – Mainly due to the production of GaAs solar cells and Li-Ion batteries

– The option using hydrazine for both, nominal manoeuvres and de-orbiting, is the more environmentally performing.

– Propellant production and burning have a high impact. Cryogenic concept is therefore more performing than VEGA in nearly every scenario. This issue merits further research as it's very difficult to model the propellant burnt with the available LCA methods.

– The ground station usage has been shown to have a small effect. It depends a lot on the assumed energy mix (Sweden in this case).

– The use of LCA by ESA

  – To make the LCA results exploitable for ESA, extra effort has to be put in adapting the tool and its databases to the specificity of the space projects.

    – Development of an ESA library would mean much faster and precise calculations.

  – It would be interesting to investigate environmental impact at high altitudes.

    – Impact method ReCiPe that is still being further developed could be a good opportunity to assess this kind of analysis.

– LCA is better adapted to mass production products LC where the impact related with the production is far higher than the development process one.

– The inclusion of LCA in pre-phase A studies may be of interest as it provides the managers with the means to support eco-design solutions. Nevertheless it has to be kept in mind that this analysis would refer to a very small part of the overall mission impact.

– LCA can also be used for technological trade-offs and to provide data lists of environmental impact indicators and guidelines for the design process.

TEC-Q: Product Assurance and Safety Department, part of Technical and Quality Management Directorate

Contacts: Jack Bosma, Mikko Nikulainen, Marc Van Eesbeek, Thomas Rohr

- Establishment and implementation of quality policies, requirements and standards
- Provision of expertise and support for product assurance and safety
- Independent assurance function for ESA projects
- Functional responsibility for product assurance and safety personnel
- Coordination of standardization
- Ensures consistency of ESA quality management requirements
- Product Assurance and Safety disciplines comprise Product Assurance management, technical risk management, dependability, safety, quality assurance, EEE components assurance and engineering, materials and processes.

The role of TEC-Q related to SD

Identification of shortcomings in space industrial manufacturing capabilities:

- Dependence from single sources, more critical if non-European (e.g. ITAR)
- Production shortfalls
- Sustainable development and related regulations (e.g. RoHS, REACH) may have large impact on availability of materials, processes, and components
- Production stops

Sustainable development is one element that can lead to deficiencies.

In a more general sense → **obsolescence**

Need to identify risks in early stage for effective mitigation

Causes for obsolescence

Regulations/ legislations

Environmental: REACH, RoHS,

Political: ITAR, EAR

Economical

Industrial policy: restructuring & merging of companies; rationalisation of processes

economical crisis (Worldwide financial crisis could be the major driver)

Technical evolution

Outdated, space becomes only user

Space Industry is conservative when compared to COTS

EEE components

Components development and manufacture may be affected by RoHS and REACH

ESCC: European Space Components Coordination

European System for the qualification and procurement of EEE space parts, based on the partnership between users, manufacturers and agencies.

Under the responsibility of the Space Component Steering Board (SCSB):

- ❍ Formulation of harmonized strategic programs and work plans for R&D, evaluation and qualification of EEE space components → Components Technology Board (CTB)

- ❍ Definition of ESCC policies and standards → Policy & Standards WG

CTB has watch-dog responsibility and refers specific RoHS and REACH issues to standing or ad-hoc advisory Working Groups.

Primary concern: Pb-free → pure Tin terminations – Tin Whisker problem and lead free solders in assembly.

Next issues expected in test methods and production processes.

CTB- M&P WG

The Components Technology Board (CTB) has created a WG whose goal is to tackle in a pro-active manner sustainability and obsolescence issues in the field of Materials and Processes.

Major concerns are how to:

- ensure appropriate configuration control at M&P level.

- deal with the impact of sustainability and obsolescence on availability

- solve potential programmatic and technical issues resulting from above

- limit resources needed for re-qualification of new or modified materials

M&P issues under investigation

The product assurance and safety department seeks to mitigate the risk of obsolescence in the fields EEE components and M&P. Current activities cover:

- Alternative coating with less environmental impact for lightweight alloys (e.g. Alodine, Anodisation...)

- Lead-free soldering alloys for electrical components

- Organic solvent free thermal control coatings (paints)

- Propellant simulants

ESA Activities in Green Tech
eg. MELISSA
http://ecls.es.int/ecls
http://www.ipstar.nl

Since 1987, ESA is strongly active in Environmental Control & Life Support System (ECLSS):

– Air recycling,

– Water Recycling

– Waste Valorisation,

– Food production and preparation

– Associated quality control and system studies (ALISS

With two key objectives :

- Survival in space environment,

- Planetary protection.

For Complete ISS:

– Total Volume: ~ 1200 m3

– Crewmembers Nominal: 6

– Density: ~5 million inhabitants / km3

– The Netherlands: 25000 times lower than ISS.

– Singapore: 1800 times lower than ISS.

– Manned missions implies:

  – High level requirements (mass, energy, risk,..)

  – High characterisation, understanding and modelling,

  – Safety (chemical and microbial)

– Several SYSTEM tools are generically used:

  – ALISSE (trade-off of architecture system)

  – MARS (Development Reference for multidisciplinary application)

 – SMARTEAM (knowledge management).

39

Ground Demonstrator
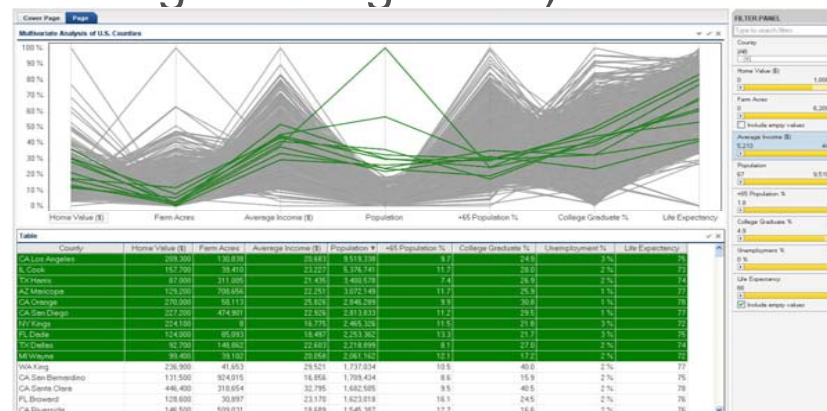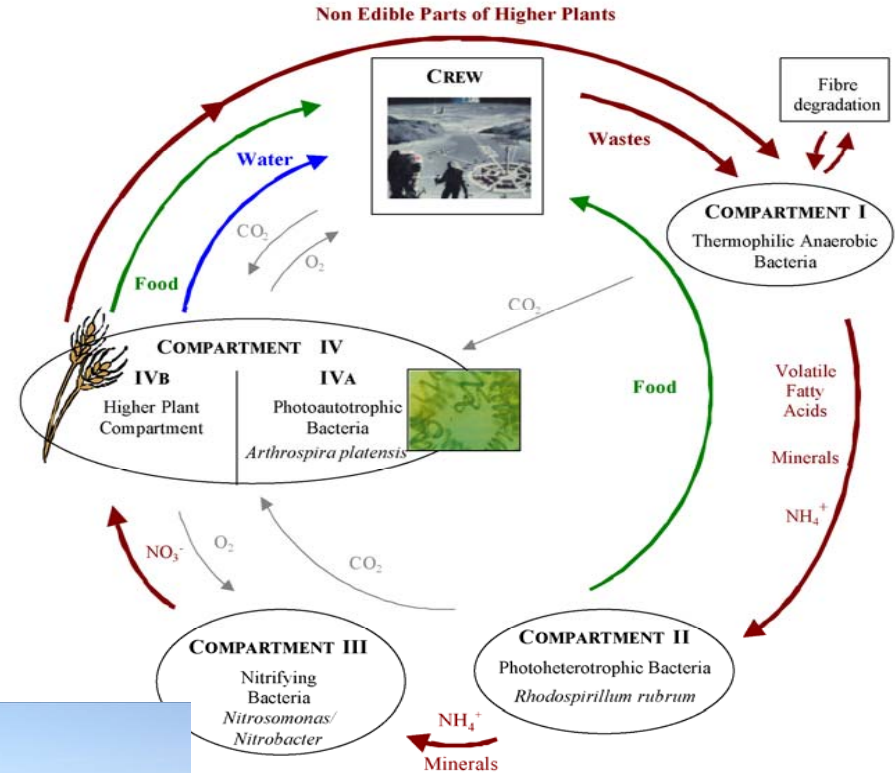
– ESA life support technologies are progressively assembled and tested with an "animal –crew".

– First Closed loop test targeted for 2015.

– MELISSA Project Manager: Christophe Lasseur
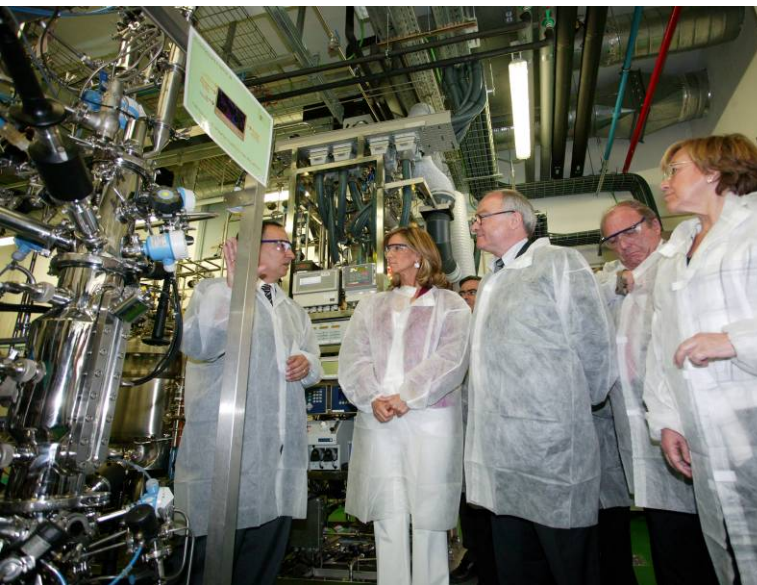
– Several successful terrestrial applications,

  – Water: 1 800000 m3 waste water Daily treated

  – Agro-Food: 160 Millions bottles/year

– Creation of Two Spin-off companies:

  – IP Star (green Tech),

  – EZi Col (Pharma)

On-going SD actions concerning support activities
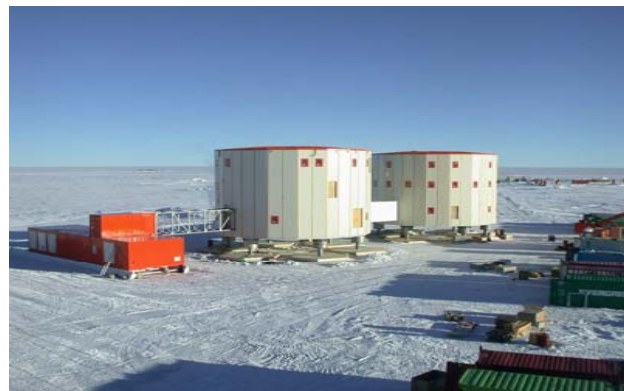
–   We previously saw that environmental and energy topics are already in ESA's core business activities and missions which **contribute to a sustainable society (**Earth explorer and Earth watch programs, GMES, Climate change initiative, IAP (Integrated Applications program) and DUE (Data User Elements), Space for Energy…), and that also teams in Programs activities also integrate the new environmental regulations and material obsolescence constraints, and reflect on eco-design and LCA (Life Cycle Analysis).

   •   but no formal policy until now has been issued with regard to ESA's internal operations.

–   Need for it : for having an institutional framework, to allow the organisation to act in that domain in a structured and pro-active way.

Basics for such a policy:

- Supported and promoted by DG with one major commitment :reduction of ESA's carbon dioxide and GHG emissions by either 20% in 2020 or 30% in 2025 + other goals and targeted actions by field of application: eg. travel policy, water management, waste management, procurement requirements, energy management (measures should also be adapted to each site specificities), creation of a building and reburbishment code applicable to all ESA sites…

- 1st and main chapter of the future corporate Sustainable Development policy

- Comes as a complement to other existing policies such as the Health and Safety policy, the certification process policy, the policy concerning ESA establishments and centres, the Council document on short-term evolution of ESA sites and infrastructures.

- Reminder about legal considerations

- Defined roles and responsibilities among the different Directorates concerned in coordination with the Sustainable Development Office

- Dedicated organisation and means (Local environmental management systems with local experts + technical coordinator (in D/OPS) + support/ reporting by Coordination Office on SD).
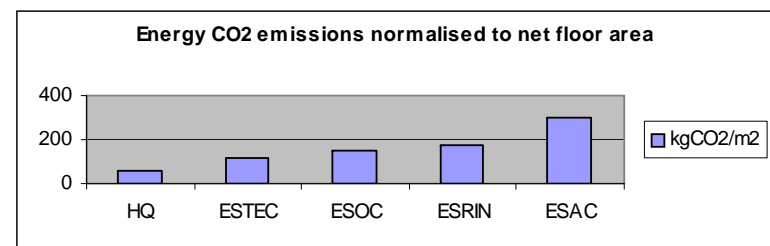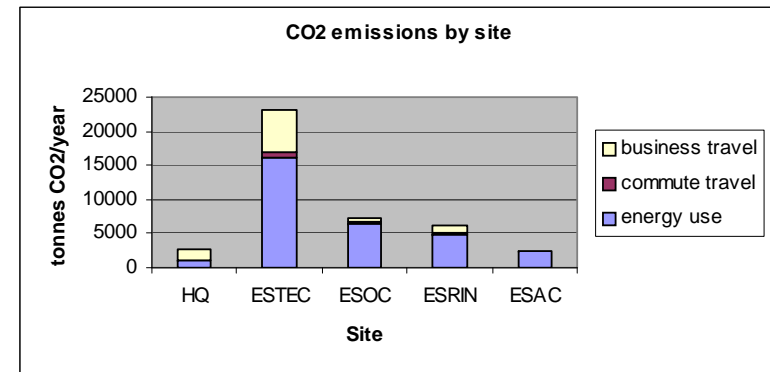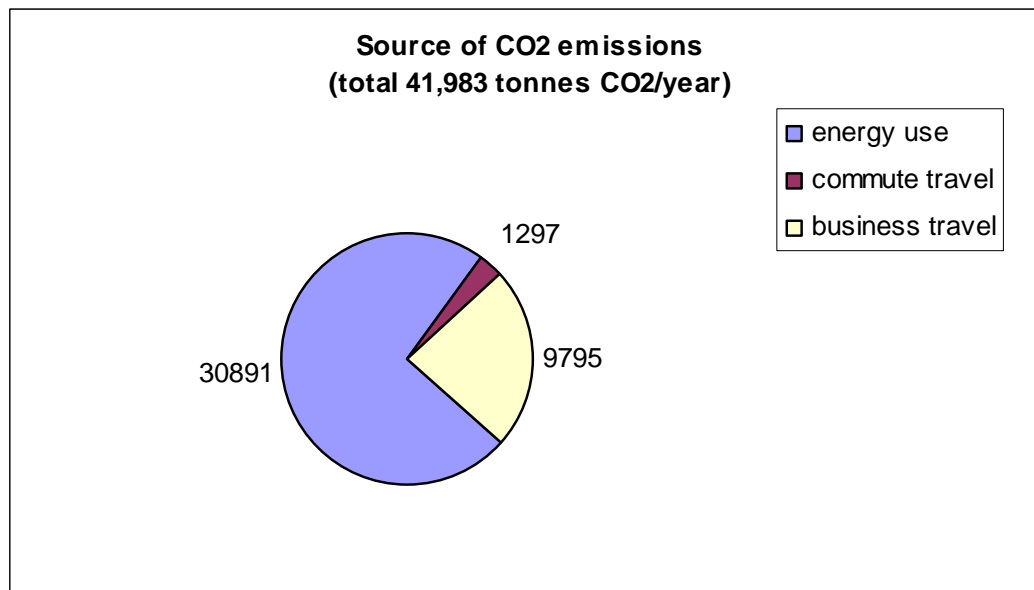
The business case based on the GSP Study on ESA's environmental footprint

- Assessment of the current impact of ESA operations on the environment (5 sites : HQ, ESTEC, ESRIN, ESAC and ESOC)
  - Along the lines of the ISO 14000 and EMAS scheme (Survey with "Significant aspects registers" for each site)
  - By analysing the efficiency of the ESA buildings and infrastructure
  - By assessing European regulations and local existing and expected legislation

- A Way forward is proposed to reduce the environmental footprint of ESA :
  - Improvements identified and business plan is proposed for implementation at short / medium / long term
  - In parallel and to support it an environmental and energy policy for ESA internal operations is also proposed

Environmental footprint :

– ESA's main European sites, HQ, ESTEC, ESRIN, ESAC and ESOC do not represent overall an unexpectedly high (or low) environmental burden.

– The most significant environmental aspects of ESA's five main European sites are Green House Gas emissions from Buildings energy consumption and business travel.

Source of CO2 emissions
(total 41,983 tonnes CO2/year)

- energy use
- commute travel
- business travel

1297
9795
30891

CO2 emissions by site

- business travel
- commute travel
- energy use

Energy CO2 emissions normalised to net floor area

- kgCO2/m2

Survey results – Study output

- An overall and centre by centre environmental footprint related to ESA operation is now available.
- "Significant aspects registers" of each site have been measured along the lines of EMS (ISO 14001 and EMAS) scheme providing:
  - Clear measurements for each aspect,
  - Comparing each measurement to :
    - Benchmarks (from comparable organisation – country specific)
    - Applicable Legal texts (European and National)
  - The basis for further EMS certification.
- A EMS implementation strategy is proposed on the basis of ISO14001 scheme and the preliminary Environmental Review provided by the study.
- A General Environmental Policy for ESA Operations is strongly suggested. The key objective could be a GHG reduction of 30% by 2025.
- For each environmental improvement proposed, significance, priorities are provided. For some specific improvements ROI is calculated.

The ESA environmental and energy policy should be presented to Directors then to Member-States before the end of the year.

CONCLUSIONS

– ESA/ NASA: share same language and same concerns regarding Sustainability

– Necessity to go far beyond the legislative compliance

– Sustainability is an urgent issue to be addressed as a top-priority at earth level

– Both a collective and individual responsibilty, implies a change in behaviours, on culture

– Space Agencies can help

– Exchange of best practices is essential, training and communication also

– This Forum creates great opportunities to meet and to share

Questions?