

NASA Johnson Space Center's Energy & Sustainability Efforts

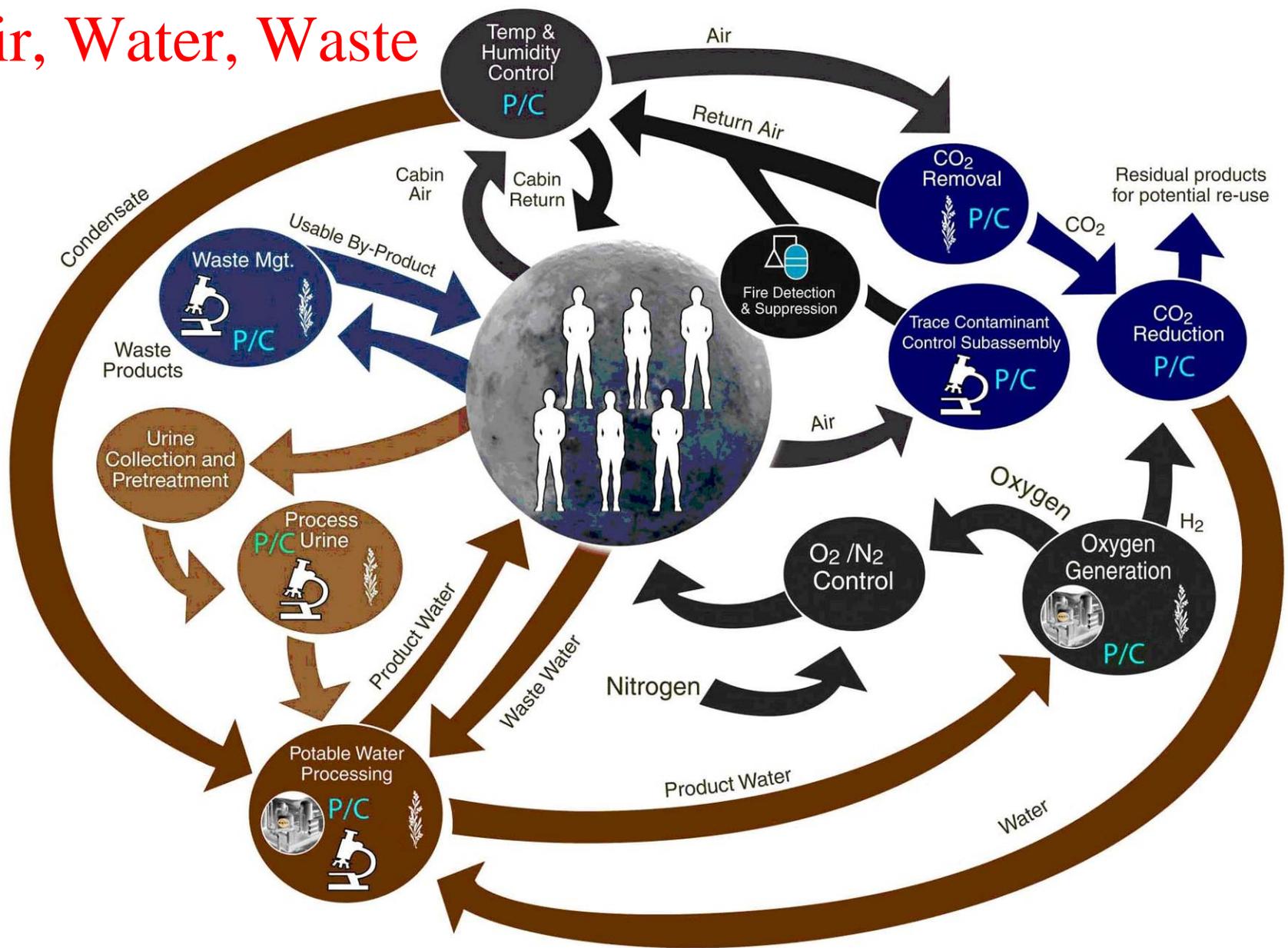
Michael K. Ewert
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Sustainability at NASA

- **Sustainability** – “Development that meets the needs of present generations without compromising the ability of future generations to meet their own needs”
- **NASA’s definition:** “Performing our mission today in ways that preserve, enhance, and strengthen our ability to perform our mission indefinitely.”
 - “JSC commits to conducting our mission in a manner that promotes environmental stewardship, sustainability, compliance, and continual improvement.” JPD 8500.1
 - The role of Technology in Environmental Sustainability is the focus of this presentation

Air, Water, Waste



In Situ Resource Utilization	Physical/Chemical System	Biological

Closed Loop Life Support

The Case for Sustainability on Earth

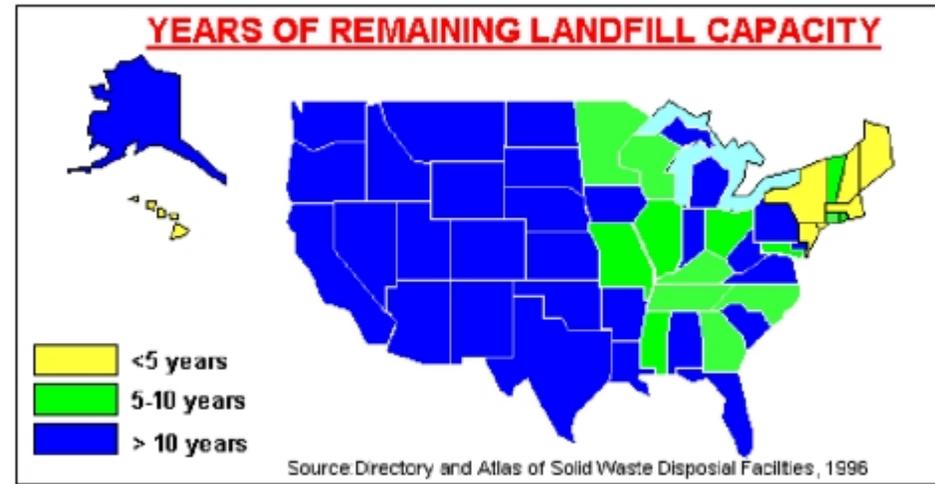


Air Pollution



Water Supply

Landfill Availability Projections



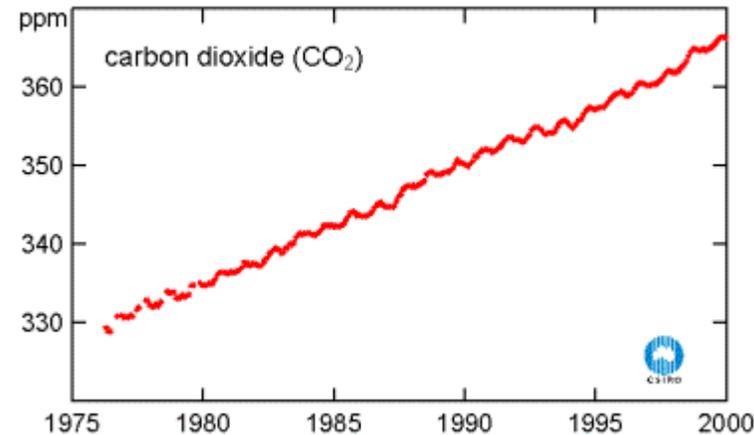
Waste



Energy Sources



Food Supply



Global Warming

JSC Sustainability Approach

Mission



Facilities

Sustainability Assessment

Resource
Utilization

Environmental
Quality

Analysis

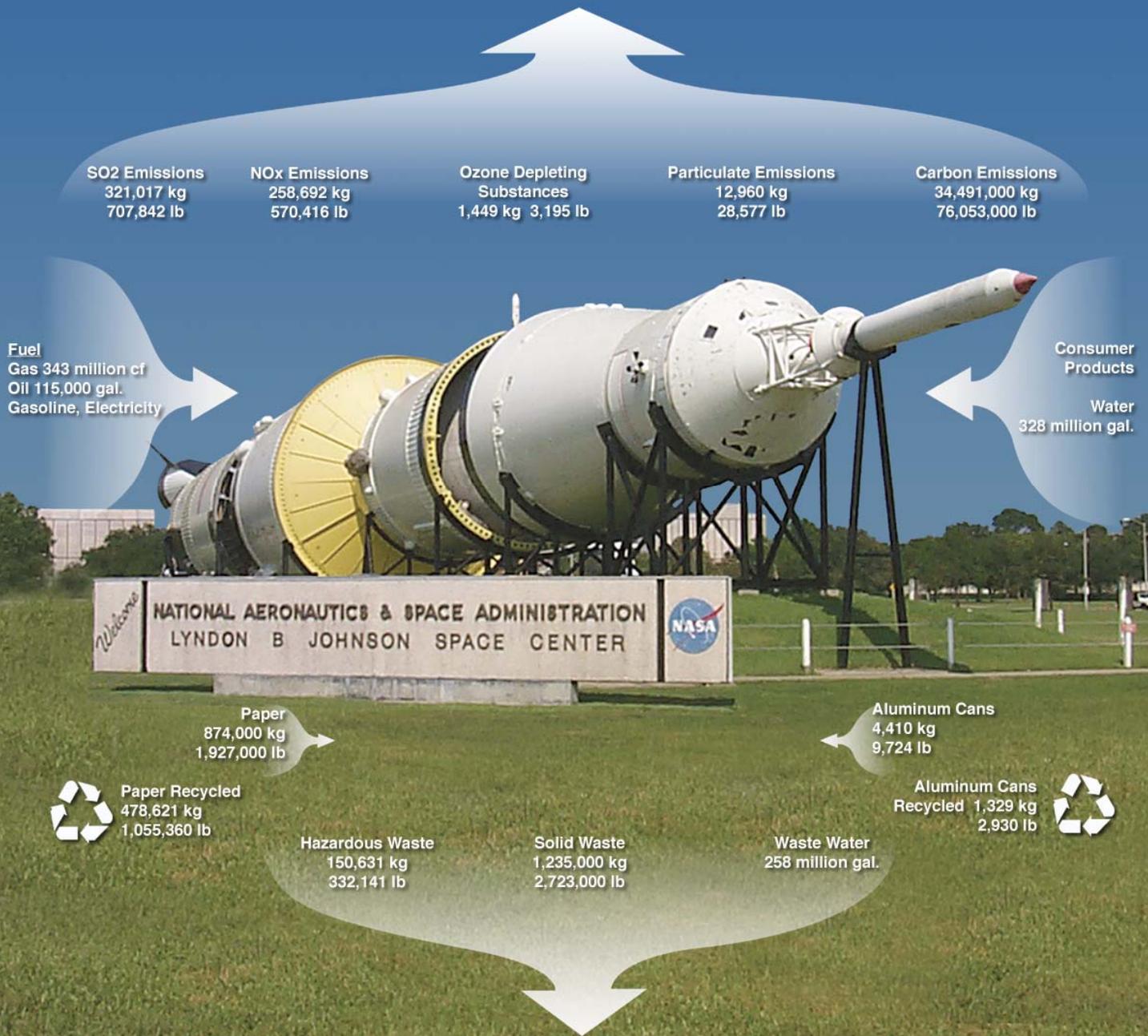
Technologies

Applications

Benefits To

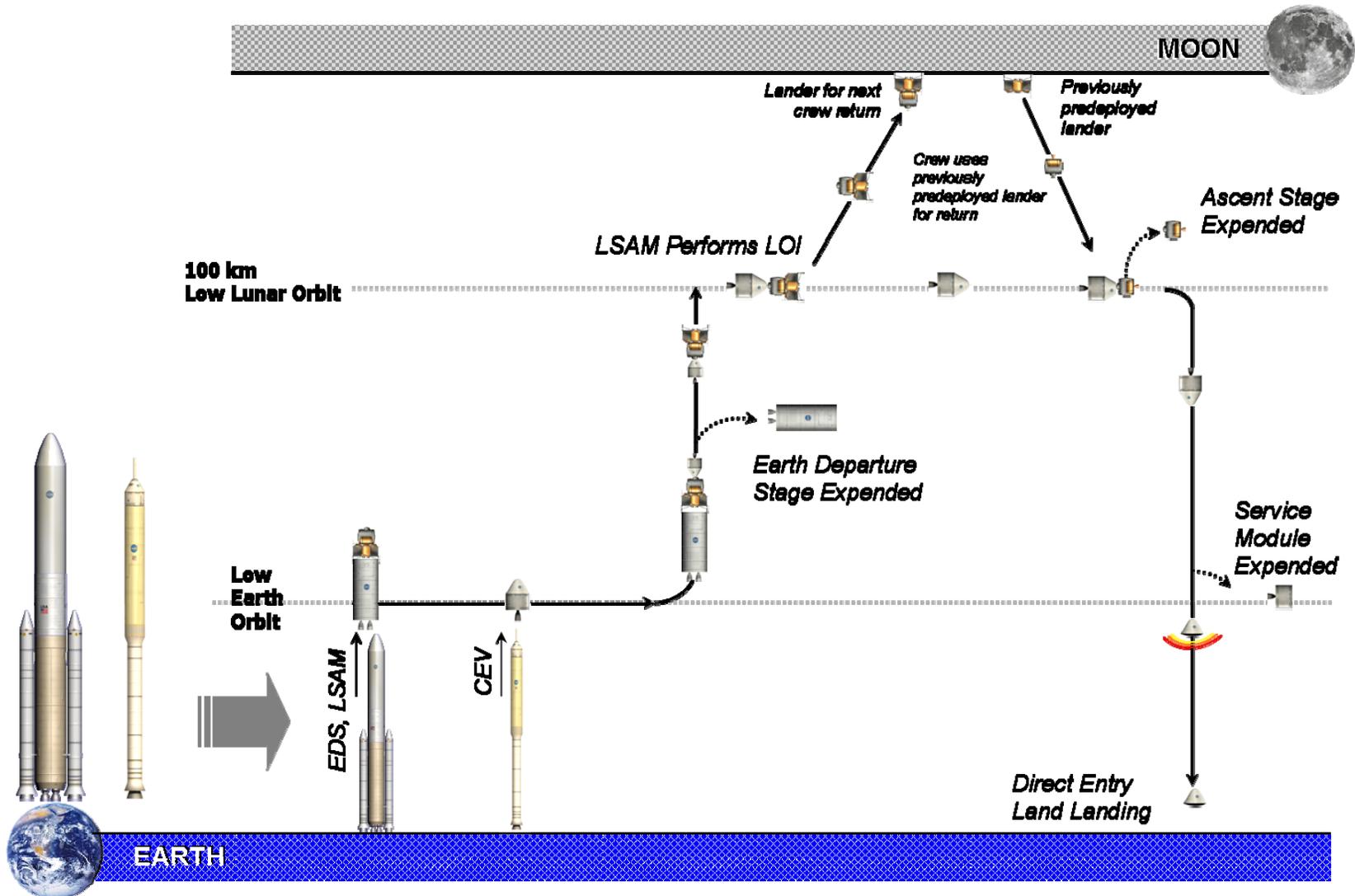
JSC, USA, World

JSC 2002 MASS BALANCE

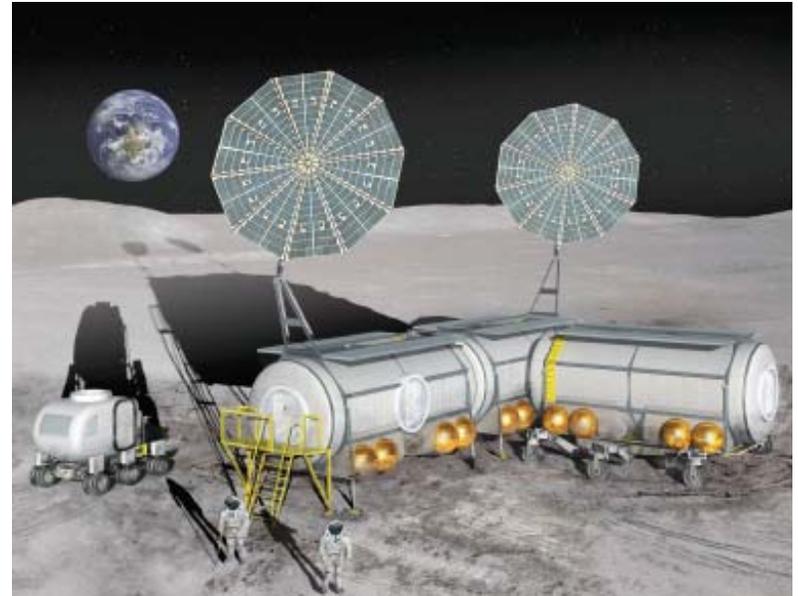


What
Can
We
do to
Reduce
Reuse
Recycle
?

Constellation Lunar Mission



New Technologies are Required for Space Exploration



Why not use them on the Ground?



Federal Energy Requirements

- **Federal Executive Order 13423 Requires:**
 - Energy intensity reduction of 3% /yr until 2015
 - Installation of solar energy systems
 - At least 50% of current renewable energy purchases must come from new renewable sources
 - Greenhouse gas reductions via energy reductions
 - Water use intensity reduction of 2% /yr until 2015
 - Petroleum reduction in vehicles of 2% /yr until 2015
 - Increase alternative fuel, hybrid and plug-in hybrid vehicles
 - Green building and environmentally sound procurement

Renewable Energy & Energy Conservation at JSC

- Solar panels to generate power for Emergency Warning System and crosswalk lights.
- Child Care Center multi-platform renewable energy system installed wind and solar PV and thermal systems, programmable thermostats and other power saving technologies.
- Solar powered lights in parking lots.
- Replacing approximately 350 parking lot lights with high efficiency fixtures.
- Purchased renewable energy credits that equal 8.8 % of site electrical use in 2007.
- Planning an energy audit in several facilities and establishing an energy awareness program for the site.
- Participating in City of Houston's Solar Advisory Council.

Sustainable Buildings at JSC

- Efforts are underway to redo or build new structures in accordance with Leadership in Energy and Environmental Design (LEED) practices.
- Certified as LEED Silver:
 - Building 27: The Astronaut Quarantine Facility.
- Designed to LEED Silver (minimum):
 - Building 207A: Gilruth Recreation Center facility addition.
 - Building 29: Constellation Avionics Integration Laboratory (under construction.)
 - Building 12: Offices (in preliminary design phase, retrofit).
- Designed to LEED Gold:
 - Building 2 North: Office of Communications and Public Affairs (under construction, retrofit).
 - Building 20: New office building (under construction).
 - Building 265: Source Evaluation Board office additions (under construction).

Formation of the Sustainability Partnership Team at JSC

NASA/TM—2004–212069



Johnson Space Center's Role in a Sustainable Future

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- 2004 Agreement between Engineering and Center Operations
 - “The purpose of the Sustainability Partnership is to bring forward, coordinate and advertise innovative sustainability ideas and projects and to share the responsibility for environmental sustainability at JSC.”

Recommendations by JSC Sustainability Team

- R&D Investment Priorities (Mission)
- Center Projects and Studies (Facilities)
- Management: *Sustainability is a unifying theme that ensures JSC can continue its mission well into the future*
 - Awareness/training at JSC
 - Commercial partnerships
 - Public relations
 - Education outreach



R&D Investments Recommended for Mission & Facilities

- Energy Efficient Habitability
 - Motors, computers, cooling, lighting, food preparation and storage, “green building”
- Renewable Energy Technologies
 - Solar
 - Regenerative fuel cells
- Electric vehicles
 - Fuel cell, PV
- Waste and Water Reuse
- Nanotechnology

Potential Project Example

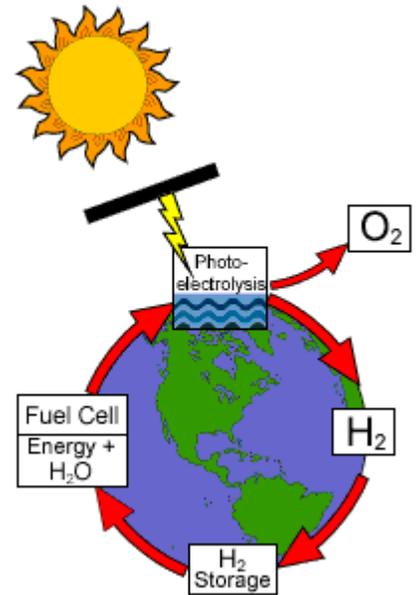
Solar Water Heater for NBL Pool



<u>Environmental Savings/ yr</u>	
<u>(% of JSC Totals)</u>	
NOx	-0.1%
SO2	0.1%
Particulate	0%
Carbon	0.1%
Electricity	-0.1%
Gas	1.2%
BTU/GSF	0.8%
Non-RE	0.4%

Conclusion

- JSC's Role in a Sustainable Future Can Be One of Leadership and Innovation!
- Sustainability is a Unifying Theme that Ensures JSC can Continue its Mission Well into the Future



Backup



For more information see: http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20040200969_2004207503.pdf

Systems Analysis Approach

- Devised 15 Environmental Sustainability Indicators for JSC
 - *Air Pollution: SO₂, NO_x, Particulates, Carbon, Ozone depleting substances*
 - *Resource Use and Waste: Solid waste, Water, Hazardous waste, Paper, Aluminum cans*
 - *Energy: Electricity, Natural gas, Diesel, BTU/GSF, Non-renewable energy %*
- Estimate Savings due to various Technologies
 - e.g. Refrigerant additive could save 2,787,000 kWh/yr due to cooling energy savings in JSC buildings (1.5% of total electricity)
- Calculate impact on Indicators
 - e.g. Also reduces SO₂ by 4,900 kg, NO_x by 3,400 kg, Particulates by 128 kg, and Carbon by 512,000 kg per year
- **Identify High Pay-off Technologies!**

Current Technologies Considered

- Air
 - Low NOx burners
- Agriculture & Food
- Energy
 - Efficiency & conservation
 - Wind
 - Solar
 - Bio-fuels
 - Various energy storage options
 - Gas turbine
 - Vegetable oil transformer
 - Backup power
- Fuel Cells
 - PEM
 - Phosphoric acid
- Green Building
 - Low heat gain roof
 - Insulating windows
 - General & exit lighting
- Thermal Control
 - Refrigerant additives
 - Artic Master
 - Heat pipe heat exchangers
 - Desiccant systems
 - Solar powered refrigeration
 - Programmable thermostats
 - Instantaneous water heaters
 - High efficiency vending machines
 - Thermal storage for A/C
 - High efficiency refrigerators & freezers
- Transportation
 - Alternative fuel vehicles
 - Segways & bikes
- Waste
 - Reduction/recycling
 - Composting
 - Super-critical water oxidation
 - Rechargeable batteries
- Water
 - Reuse for irrigation

Note: Those in blue were analyzed quantitatively

Future Technologies Considered

- Air
 - Advanced air monitors
- Agriculture & Food
 - Crop based foods requiring little energy
- Energy
 - Higher efficiency motors
 - Clean coal & carbon sequestration
 - Nuclear fusion
 - Solar (inc. [lunar PV power](#))
 - Bio-fuels
 - [Various energy storage options](#)
- Fuel Cells
 - PEM
 - Regenerative
 - [Fuel cell landscape cart & mower](#)
- Green Building
 - LED lighting
- Thermal Control
 - Micro-electromechanical systems (MEMS) cooling devices
 - Better refrigerants
 - [High efficiency centrifugal chiller](#)
 - [Desiccant cooling systems](#)
 - Solar powered refrigeration
 - Vacuum insulation
 - Phase change material refrigerator
 - [Refrigerator efficiency improvements](#)
- Transportation
 - Fuel cell vehicles
 - Hypercar
 - Aerial vehicles
- Waste
 - Composting
 - Super-critical water oxidation
 - Disposable cup/utensil alternatives
- Water
 - [Reuse for irrigation](#)

Note: Those in blue were analyzed quantitatively

Example JSC Sustainability Team Accomplishments

- Solar PV Recharge Station for JSC's Mars field test site

- To replace portable gasoline generator

- DOE study of Critical Backup

Utilities for JSC

- Applied for and received technical assistance from DOE/ORNL

- Assessed combined heat and power via gas turbines

- Polarized Refrigerant Oil Additive

- Reported to save 15% or more energy in air-conditioners

- Performed a test with several units at Gilruth



Ex. Environmental Sustainability Issue: Ozone Depletion

- Caused by the release of chlorofluorocarbons (CFCs) and other ozone-depleting substances
 - Refrigerants, insulating foams, solvents
 - One chlorine atom can break apart more than 100,000 ozone molecules
- Health effects due to stratospheric ozone depletion include skin cancer, cataracts, and weakened immunity
- NASA has played a key role in identifying and monitoring the issue
 - Montreal Protocol is a plan for phase-out
 - JSC has phased out CFC's on-site
- Scientists predict the ozone hole could close within 50 years

