Opportunities for CISE Researchers in Sustainability

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Oct 14, 2011, 13:00 – 14:45
Welcome by

Dr. Farnam Jahanian
Assistant director
CISE Directorate

Dr. Keith Marzullo
Division Director
Computer & Network Systems (CNS) division
Agenda

13:00 Welcome by CISE Management

13:10 Overview of SEES – Jessica Robin, Krishna Kant

13:25 SEES solicitations

• Sustainable Energy Pathways – Krishna Kant
• SRN and RCN-SEES – Krishna Kant
• SEES Fellows – Petros Drineas
• PIRE-SEES, CNH, WSC – Petros Drineas

14:15 Questions
The Sustainability Challenge

Dr. Jessica Robin
Office of International Science and Engineering
A World Under Pressure

There are increasing natural and anthropogenic pressures on our natural and social systems

- 3 major earthquakes in 2010-2011 – Haiti, Chile and Japan
  Japan also experiencing tsunami & nuclear crisis simultaneously.
- Unsustainable population growth & its impact
- Diminishing resources such as fresh-water, forest cover, and others
Sustainability Issues Remain at the Forefront

- Sustainability issues remain at the forefront both in academic journals and popular media.

- Sustainability science is emerging as a new academic discipline

Neither “basic” nor “applied” research but as a field defined by the problems it addresses rather than by the disciplines it employs.

-- William Clark in Proc. of National Academy of Sciences
The Challenge of Sustainability

What is Sustainability?

The interactions between natural and social systems, and how those interactions affect the challenge of... meeting the needs of the present and future generations while substantially reducing poverty and conserving the planet’s life support systems.

It is more than just climate change or energy, or disaster response, or ...

It is research at the nexus of societal needs and behavior, environmental impact, and economic demands.

Sustainability

- Society
- Economy
- Environment
Meeting the Challenge

Role of Science and Technology

- Inform decision making to drive policy
- Create new products and capabilities with deep societal impact
- Prepare the workforce to address global change

Understanding change and projections of impact

Adaptation methods and technologies

Mitigation actions and technologies

Human well-being on a crowded planet

Requires multifaceted approaches
Science, Engineering, and Education for Sustainability (SEES)

To advance science, engineering, and education to inform the societal actions needed for environmental and economic sustainability and sustainable human well-being

**GOALS**

- Support interdisciplinary research and education that can facilitate the move towards global sustainability
- Build linkages among existing projects and partners and add new participants in the sustainability research enterprise
- Develop a workforce trained in the interdisciplinary scholarship needed to understand and address the complex issues of sustainability
Prior NSF SEES Activities

- NSF sponsors 5 climate focused solicitations in FY10
- NSF issues Dear Colleague Letter
- NSF continues to support SEES efforts through FY11

- Earth Systems Modeling (EaSM)
  - $50-$35M total awards including DoE & USDA
- Ocean Acidification (OA)
- Dimensions of Biodiversity (DB)
- Water, Sustainability, and Climate (WSC)
- Climate Change Education (CCEP)

- Issued on January 2011 (NSF 11-022)
  - Informs community on the planned future of SEES activities

- Research coordination networks (RCN)
- Couple natural human systems (CNH) solicitation
- Planning workshops, fostering international collaboration, and more
Fiscal Year 2012 Priorities

• Advance a clean energy future
• Nurture the emerging SEES workforce
• Expand research, education, and knowledge dissemination
• Develop interdisciplinary research networks
• Engage with global partners

Tremendous opportunity to build on NSF strengths and efforts
# Role of CISE in SEES

## Monitoring

- Scalable sensing & data collection for sustainability apps
  - Ocean ice dynamics
  - Biodiversity tracking,
  - Water quality & availability
  - Disaster monitoring
  - Human well being (e.g., healthcare for masses)
- Sensing in difficult environments (e.g., arctic, wild-fires, animals)
- Working with citizen science data

## Big Data

- Involves processing massive data:
  - Integrating multimodal data
  - Dealing with missing/unreliable data
  - Storage and dissemination
  - Management, visualization and understanding

## Foundations

- **Addressing complexity**
  - Problem abstractions
  - Multi-level modeling
  - Symbolic/numeric modeling
  - Reasoning in uncertain environments
  - Crowdsourcing
  - Autonomous Control
- **Addressing scale**
  - Algorithms in the field
  - New architectures
  - Multicore & cloud computing
  - Software engineering
Workshops Exploring Sustainability

• US-China workshop on CS & Sustainability Challenge
  – DIMACS, Rutgers University, Sept 2011
  – http://dimacs.rutgers.edu/Workshops/China4/program.html

• Workshop on info. & comm. technologies for sustainability
  – SECON, Salt-lake City, June 2011

• Role of Info., Sci. & Eng. In Sustainability
  – CCC workshop, Washington DC, Feb 2011

• Science of sustainability workshop
  – Warrenton, VA, Nov 2009
# CISE Centric Sustainability Programs

**Core**
- Energy efficient IT design and energy management
- Sensor networks and embedded computing for sustainability applications
- Increasing interest in broader sustainability aspects of computing

**Cross Cutting**
- Programs include Cyber Physical Systems (CPS) and Smart Health and Wellbeing (SHW)
- Includes projects in smart homes/buildings, smart grid, vehicles, healthcare, and more

**Large Scale**
- CISE Expedition awards funds up to $2M a year for up to 5 years
- Awards include projects on Computational Sustainability (Cornell) and Data Driven Climate Modeling (University of Minnesota)
Current SEES Portfolio

CISE Sponsored 2012

**SEP**
Sustainable Energy Pathways

**SRN SEES**
Sustainability Research Networks

**RCN SEES**
Research Coordination Networks

**PIRE SEES**
Partnerships for Int. Rsrch & Edu

**SEES Fellows**
Preparing New Researchers

Others 2012

**WSC**
Water Sustainability and Climate

**CNH**
Coupled Natural Human Systems

**OA**
Ocean Acidification

Past – not available

**EASM**
Modeling Earth Systems

**DBD**
Dimensions of Biodiversity

**CCE**
Climate Change Education
Common SEES Solicitation Requirements

**Must be interdisciplinary by design**
- Proposals fundable by core program of directorates not suitable.
- Integration of multi-disciplinary parts is important

**Must promote interdisciplinary education & training**
- Integrating multi-disciplinary education into core curriculum
- Enhancing cross disciplinary interaction
- Creation of infrastructure for multidisciplinary research
- Enhancing public’s understanding of sustainable energy future

**Must go beyond just creating technologies – need to consider social, economic, and environmental aspects**
- Proposals requires only consideration, not in-depth treatment.
- Depth of treatment depends on proposal scope
FY12 Solicitations

1. SEP
2. RCN-SEES
3. SRN
4. Fellows
5. PIRE
6. WSC/CNH
# Sustainable Energy Pathways

To develop efficient pathways towards sustainable energy, from starting points to ending points, via a systems approach in the priority areas of

- **Sustainable Energy Harvesting, Conversion, and Storage**
  - Energy harvesting and conversion
  - Energy storage solutions
  - Critical elements and materials
  - Nature inspired processes
  - Reducing carbon intensity

- **Energy Transmission, Distribution, Efficiency, and Use**
  - Transmission and distribution
  - Energy efficiency and management

## Amount

- $34M for 15 -20 awards

## Awards

- Up to $500K/year
- Up to 4 years

## Requirements

- At least 3 PIs (one lead, 2 co-PIs)
- Represents 2 or more disciplines

## Restrictions

- Max 3 proposals per organization
- Max 1 proposal per PI

**Due Date, Feb 01, 2012**
The extent to which the proposal articulates SEP vision

- Embraces the overarching theme of sustainability,
- Develops and integrates scientific knowledge & technological innovation, with environmental, societal, & economic aspects.

Synergistic engagement of multiple disciplines

- As reflected in the research plan, expertise/roles of PIs, and the project management plan

Integration of education & workforce development in research

- As reflected in the potential effectiveness and impact in educating students and promoting public understanding of sustainable energy
Key Considerations in SEP Vision

- Does the adoption require behavior change & how could that be effected?
- Is the technology likely to have adverse environmental impact?
- Does the technology depend on future breakthroughs for economic viability?
- Is the technology viable from a policy, cultural or societal perspective?
- Does the technology depend on scarce natural resources?
What is a Sustainable Energy Pathway?

A set of coordinated and well orchestrated steps to advance the goal of a sustainable energy future

Example 1
- Energy source
- Smart conversion
- Intelligent transport
- Efficient Use

Example 2
- Legal/policy action
- Change in incentives
- Sustainable technologies
Energy Sub-Pathway for Transportation

Conversion from Ethanol crop to Ethanol → Ethanol transportation & distribution → Vehicle level storage & use of Ethanol

Electricity from wind/solar → Electricity transportation & distribution → Vehicle level storage & use of Electricity
Building the Entire Pathway

Conversion from Ethanol crop to Ethanol

Ethanol transportation & distribution

Vehicle level storage & use of Ethanol

Interaction showing Ethanol transportation by vehicles

Coordination of vehicular energy use over a region

Integrated vehicular use of Energy

Electricity from wind/solar

Electricity transportation & distribution

Vehicle level storage & use of Electricity

Interaction showing local use of available energy

Smart Adaptation to energy demand & supply
Some CISE Research Opportunities

Optimization of transmission & distribution systems for raw materials, fuels & energy

Smart local monitoring (inside & around vehicle) and energy management

New technologies for energy routing & storage mgmt

Conversion side energy management, availability prediction & optimization

Global monitoring (e.g., metro region wide), data collection & analytics

Integration, resilience, and survivability of energy networks

Site selection & capacity planning of “filling” stations

Global energy management (scheduling, platooning, …), robustness and security
Research Coordination Networks

**Amount**

$7.5M to $17.5M (pending availability) for 15-25 awards

**Awards**

Up to $750K total
Over 4 - 5 years

**Requirements**

No collaborative proposals; only subawards by lead institution

**Restrictions**

No participation limits

- Existing program with SEES track added for FY12
  - CISE supporting only the SEES track

- Supports collaboration between existing research efforts
  - Does not support research activities, only networking activities
  - Intended for creating new networks, not sustaining old ones

- Expected to include diverse organizations
  - International participation highly encouraged & expected to be of mutual benefit
  - Just involving multiple CS/CE participants is inadequate

**Due Date: Feb 03, 2012**
11 awards given in 2011, two of them co-sponsored by CISE

Sustainable Energy Systems
Arizona State U
Award: $750,000
Sponsors: CISE, OISE+
A collaborative network of University Centers, industrial partners, and regulatory agencies.
Seeks to exploit multidisciplinary advances in nanotechnology related to energy generation (e.g., photovoltaics), storage (e.g., batteries), and transmission (e.g., integration of renewables in the electric grid).

Sustainable Cities: People and the Energy-Climate-Water Nexus
Univ of Colorado at Denver
Award: $749,930
Sponsors: CISE,GEO,MPS+
A national network of researchers from 20+ US Universities and 2 National Labs. Collaborates with international sustainability research networks (in Australia, EU, Asia).
Research has an emphasis on reducing energy use and carbon emissions and mitigating climate-risks to water supply and public health in cities.
Two Past RCNs (2007)

**GLEON**
Global Lake Ecological Observatory Network

A network of limnologists, ecologists, IT experts, and engineers to build a scalable network of lake ecology observatories

**FluxNet**
A Global Network of Flux Tower Networks

An infrastructure to collect and distribute data using a global array of towers that measure CO2 exchanges, water vapor, and energy between biosphere and atmosphere.
Sustainability Research Networks

- Goes beyond RCN-SEES
  - Intended for much larger, nationally important sustainability themes
  - Can fund gaps or new essential research for a comprehensive thematic coverage.
  - Can enhance existing research networks

- Encouraged to develop linkages with other networks, government entities, and the private sector, both nationally and internationally

- Multidisciplinary education and training are crucial components

**Amount**

$36M for 3 - 4 awards

**Awards**

Up to $2.4M/year for up to 5 years
Amount requested to be consistent with project scope

**Restrictions**

Max 3 proposals per organization
Max 1 proposal per PI
No collaborative proposals; only subawards by lead institution

**Preliminary Due** December 1, 2011
**Full Due** April 1, 2012
**Site Visit** Summer 2012
CISE Opportunities in SRNs

SRNs involving coordination of complex IT-infused ecosystems, e.g., large scale e-health or smart transportation systems,
Interactions between consumer segments of a resource

by contributing on CISE aspects of sustainability themes such as understanding, mitigation, and adaptation to global change, or responding to extreme events

in the future, and tap into a funded SRN via a RCN, PIRE, another SRN, or other project

PARTICIPATE

CONNECT
SRN Review Criteria

Preliminary proposals

• Is the vision sufficiently compelling to justify the investment?
• Is there a framework to address social, economic, and environmental components?
• Is the goal of overcoming barriers to sustainable well-being addressed?
• Are the approaches proposed innovative and flexible?
• What are the contributions of partners and the management structure?
• Does the SRN leverage existing research/education nodes?
• Is there a plan to develop workforce for the tackling complex issues of sustainability?

Additional considerations for full proposals

• Quality of management plan and team
• Quality of educational activities and efforts to broaden participation
• Level of community participation and external engagement
Situation:
80% of US population lives in cities
Huge ongoing migration to cities in developing world

Complication:
Megacities consume resources at prodigious rate
How do we develop sustainable urban systems?

Resolution:
There are many opportunities for the CISE community to join in the search for solutions (e.g., energy, food, water, health, transportation)
Potential SRN Theme: Energy Dynamics

Coordination of energy conversion, distribution, and consumption across multiple segments, e.g.,

- Distributed electricity generation from multiple sources and its two way flow
- Electricity consumption in homes, offices, factories, data centers, vehicles, etc.
- Fuel distribution & use in transportation systems, heating systems, etc.
# NSF SEES Fellows

To create the necessary workforce to enable discoveries leading to environmental, energy, and societal sustainability

- The Fellow's proposed research should:
  - Cross traditional disciplinary boundaries
  - Go beyond his/her current core disciplinary expertise
  - Address issues of sustainability through a systems approach
  - Build bridges between academic inquiry, economic growth, and societal needs

- Fellows must develop a research partnership in order to broaden the impact/scope of the proposed research

- Fellows are expected to devote time to a professional development activity

## Requirements

- Applicants must be US citizens, nationals, or permanent residents
- Applicants must have received PhD within 4 years of deadline

## Restrictions

- One proposal/PI

## Awards

- 2 - 3 years of fellowship costs
- $88K/year in salary, $20K/year in research expenses, $10K/year in international research costs

## Amount

- $6 - 8M for 12 - 20 awards

Due: December 5, 2011
Due Thereafter: First Monday in December

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**NSF 11-575**
• Intellectual merit & broader impact criteria
• Additional criteria: will the proposed project
  • SEES-related
    • Integrate across NSF-supported disciplines by creating new interdisciplinary networks/collaborations?
    • Advance the foundations of sustainability?

• Research Host and Research Partner
  • Help the applicant expand beyond his or her current core disciplinary expertise?
  • Via the research partnership, broaden the impact and/or scope of the proposed research?
  • Via international partnerships, bring mutual benefit of expertise, facilities and/or resources?

• Professional development
  • Enhance the applicant's professional growth while complementing the proposed research?
Partnerships for International Research and Education (PIRE)

Goals:

To facilitate development of a diverse, globally engaged US science and engineering workforce.

To promote opportunities where international collaboration can enable advances that could not occur otherwise.

To engage and share resources and infrastructure within and across institutions to build international partnerships.

- FY2012 solicitations focuses solely on SEES topics
- Encourages research on global sustainability including climate change, clean energy, food security, biodiversity, and communication networks.
- Proposals should address linkages across natural social and/or built environments

Amount

$10 - 15M (annually) for 10 - 15 awards

Awards

$4M expected average award
Over 5 years

Requirements

Preliminary proposals required

Restrictions

1 proposal per institution (as lead)

Preliminary Due October 19, 2011
Full Due May 15, 2012
## Additional Opportunities for CISE

### Coupled Natural Human Systems
- Quantitative, interdisciplinary analyses of human and natural system processes and complex interactions at diverse scales
- Support for exploratory awards & RCN

**NSF 11-612**
- **Amount**: $17 for 5 - 17 awards
- **Awards**: $150K to $1.5M, depends on award type
- **Due**: November 15, 2011

### Water Sustainability and Climate
- Modeling to predict impact of climate variability and change, land use, and human activity on water systems.
- Developing adaptive water resource management
- Designing water systems to be more resilient and sustainable to meet diverse and conflicting needs

**NSF 11-551**
- **Amount**: $31M for 12 - 26 awards
- **Awards**: $150K to $1.5M, depends on award type
- **Due**: October 19, 2011
An Opportunity for CISE Community

Here lies an opportunity to make research contributions with substantial societal impact.

Sustainability is an extremely rich and challenging field.

CISE expertise & skills are key to addressing overwhelming complexity.

The Time is Now

Sustainability problems are not going away.

Support for sustainability research continues to expand.

Please Participate!

10/21/11

NSF CISE SEES Webinar
Additional Resources

• SEES web links
  – Master site: www.nsf.gov/sees
    • Will have a link to this presentation

• Questions
  – General queries on solicitations:
    • sep@nsf.gov, srn@nsf.gov, seesfellows@nsf.gov, PIRE-info@nsf.gov
  – SEES queries:
    • General: nsf-sees-info@nsf.gov
    • Discipline Specific: http://www.nsf.gov/geo/sees/sees_contacts.jsp
Questions?

Fellows: pdrineas@nsf.gov, SEP, SRN, RCN: kkant@nsf.gov