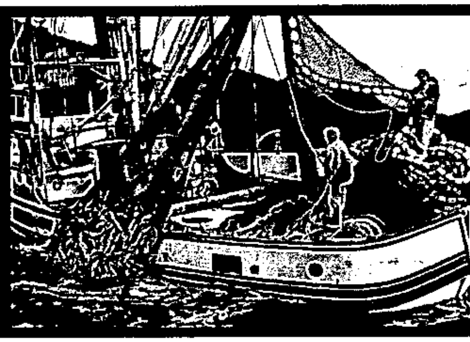
2-10-09 Alaska's Role in the Global Marketplace

<target><bill></bill><subject>2-10-09 Alaska's Role in the Global Marketplace</subject><comm>SWTR26</comm></target>

Growing Alaska's Economy Through International Trade



WORLD TRADE CENTER
ALASKA

International Trade is Big Business for Alaska:

- In 2007, Alaska's exports to overseas markets reached $3.9 billion, forty-second among the states.
- Exports represent 10% of the state's overall economy. This ranks Alaska eighth in the nation (2006).
- Measured on a per-capita basis, Alaska ranks fourth in the nation.
- Exporting supports thousands of jobs statewide. These are among the highest paying jobs in the state.
- Export markets enable Alaskan companies to expand their customer base and product mix.
- 77% of exporters in Alaska are small and medium sized companies.
- Small and medium sized companies accounted for 13% of Alaska's exports (by value).

Overseas Companies Have Made Significant Investments in Alaska:

- As of 2004, cumulative foreign direct investment in Alaska reached $31 billion, the eighth highest total in America.
- Foreign companies (majority-owned U.S. Affiliates) operating in Alaska generate 11,300 jobs. This represents approximately 5% of the state's private-sector workforce.

Export Revenue reached $3.9 Billion in 2007

Alaska's Top 5 Export Markets
(Millions of US Dollars):

1) Japan ($855)
2) China ($716)
3) South Korea ($703)
4) Canada ($460)
5) Germany ($202)

Alaska's Top 5 Export Commodities
(Millions of US Dollars):

1) Seafood ($1,979)
2) Minerals ($1,187)
3) Energy ($232)
4) Precious Metals ($132)
5) Fertilizer ($92)

Sources: Alaska Seafood Marketing Institute (photo); State of Alaska, Governor's Office of International Trade; U.S. Department of Commerce, Exporter Data Base; International Trade Administration; Bureau of Economic Analysis.

Information based on 2007 figures, except where noted.

20 WORLD TRADE CENTER ALASKA twenty-years

For more information, please contact Greg Wolf, Executive Director
431 West Seventh Avenue, Suite 108, Anchorage, Alaska 99501- 3511, USA
Phone 907.278.7233 Fax 907.278.2982
eMail info@wtcak.org http://www.wtcak.org

WORLD TRADE CENTER ALASKA

TRADE DEVELOPMENT PROGRAMS

WTCAK has five focused trade development programs.

These programs are designed to give members and community partners the ideas, information and hands-on assistance to identify and pursue business opportunities in Alaska's major markets.

Four of the programs are country-specific.

These countries represent the state's four largest trading partners.

Another program is focused on new, high potential markets that are experiencing rapid economic growth.

Japan Focus is a trade development program of World Trade Center Alaska. The program provides information and services to Alaskans seeking to do business in Japan.

Korea Connection is a trade development program of World Trade Center Alaska. The program offers information and assistance to Alaskans seeking to do business in Korea.

China Calling is a trade development program of World Trade Center Alaska. The program is designed to assist Alaskans to identify and pursue business opportunities in China.

***Canada: Opportunities Next Door** is a trade development program of World Trade Center Alaska. The program helps Alaskans to pursue business opportunities in Canada.*

New Markets-New Customers is a trade development program of World Trade Center Alaska. The program aims to identify new export markets for Alaskans and assist them to pursue opportunities in these markets.

Photo Credit: Resource Development Council for Alaska, Inc.

For more information on these programs and other activities, please contact Greg Wolf, Executive Director
431 West Seventh Avenue, Suite 108, Anchorage, Alaska 99501–3511, USA
Phone 907.278.7233 Fax 907.278.2982
eMail info@wtcak.org http://www.wtcak.org

20 WORLD TRADE CENTER ALASKA *twenty-years*

WORLD TRADE CENTER
ALASKA

WORLD TRADE CENTER ALASKA IS...

Premium Level Members:

- ◆Alaska Airlines
- ◆Alaska Business Monthly
- ◆Alaska Interstate Construction, Inc.
- ◆Alaska Railroad Corp.
- ◆BP Exploration
- ◆Chugach Electric Association, Inc.
- ◆FedEx
- ◆Lynden International
- ◆Movers, Inc.
- ◆Northrim Bank
- ◆Sealaska Corp.
- ◆South Central Timber Development, Inc.
- ◆State of Alaska
- ◆Tyonek Native Corp.
- ◆United Parcel Service
- ◆U.S. Commercial Service
- ◆Usibelli Coal Mine, Inc.
- ◆Wells Fargo Bank

World Trade Center Alaska is a private, non-profit membership organization providing international trade and business services to members and community partners across the state. The mission of WTCAK is to assist Alaskans to successfully compete for trade and investment in the global market place.

The Center pursues this mission through five core functions:

Trade Capacity - help Alaska companies to become export ready through information, seminars, conferences and other technical assistance.

Trade Development - research foreign markets and identify trade opportunities for Alaska companies.

Trade Service - support Alaska companies with the information and hands-on assistance needed to make trade happen. Connect Alaska sellers with overseas buyers.

Trade Facility - make available office and conference room setting to facilitate business meetings and events.

Trade Network - provide members with access to facilities and support in more than 300 cities around the world.

How do you become a WTCAK member?
Contact: info@wtcak.org

431 West Seventh Avenue, Suite 108, Anchorage, Alaska 99501– 3511, USA
Phone 907.278.7233 Fax 907.278.2982
eMail info@wtcak.org http://www.wtcak.org

20 WORLD TRADE CENTER ALASKA twenty-years

Recent World Trade Center Testimonials

twenty-years


Mitchell

Dennis Mitchell, Regional Manager Alaska
Lynden International

"Lynden International has been a member of World Trade Center Alaska for 20 years. Our membership in this organization has been extremely successful in our viewpoint, providing interesting and timely discussions related to International Trade that is relevant to our industry. Through the auspices of WTC Alaska, we have made valuable contacts that have enhanced our business prospects and have enabled us to expand our horizon of opportunity. We encourage businesses with an interest in International Trade to become a member of the World Trade Center Alaska, and discover for themselves the benefits of membership."


Brophy

Bill Brophy, Vice President, Customer Relations
Usibelli Coal Mine Inc.

"Usibelli Coal Mine (UCM) is proud to have been a member of World Trade Center Alaska (WTCAK) for the past 10 years. WTCAK has been an important part of the team assisting UCM with successful marketing of Alaska coal to a variety of international customers on the Pacific Rim. The management team at WTCAK possesses the talent and expertise to assist with development programs, strategic planning, market surveys, special international events, and trade missions abroad. WTCAK has always been available to assist with our requirements to conduct research and coordinate with private businesses and government officials, both in the United States and with allied countries. They have been instrumental in fostering great relationships enjoyed by UCM with the Alaska Railroad Corp. and the Seward Coal Loading Facility.

UCM has enjoyed export of subbituminous coal to South Korea since 1984 on long-term contracts. During 2004 UCM established a new business relationship with Glencore Ltd., delivering more than a half million tons of Usibelli coal to three electric utilities in Chile. Over the years, UCM has also provided test shipments to Taiwan, Japan and Russia.

It is a pleasure to applaud the great work at WTCAK during November as we celebrate their 20th Anniversary!"


Strutz

Richard Strutz, Regional President
Wells Fargo Bank Alaska

"Our membership with the World Trade Center Alaska has helped us make connections with the leading international commerce organizations in Alaska. As an international financial services company with an Alaska presence, it's critical for us to develop relationships with World Trade Center Alaska members. It's very exciting for us to help local businesses expand into the global marketplace, and World Trade Center Alaska is a tremendous advocate for broadening Alaska's global commerce horizons."


Jenkins

Beverly Jenkins, President
Upscale Inc.

"The staff at World Trade Center Alaska have been very helpful to our business. We were just blown away and still are when we continue to work with their office. We feel that they go above and beyond their duties. For example, we were very excited when they took our product to China and made all the necessary contacts for us. Whenever we call them with a question, they are never too busy to help even though their office is very busy. They never seize to amaze us. Thanks so much for all World Trade Center Alaska continues to do!"


Ogawa

Yoshi Ogawa, Owner
International Travel Consultants Inc.

"World Trade Center Alaska has been a great partner in enhancing my business over the years. I first became involved with WTCAK as a corporate member of Northwest Airlines about 15 years ago. Since then, I have continued to renew my membership for the past 10 years for my own business. World Trade Center is always responsive to the needs of the members by bringing speakers with appropriate topics, and continues to educate members about current issues that are important to the international community in Alaska. WTCAK is always helpful in assisting us, from providing opportunities to networking with other members to assisting me in ways that benefit my products and services. They are also instrumental in getting the word out to the international community of our latest offerings and services in a cost-effective manner. WTCAK certainly helps my company think locally and act globally."

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Alaska's Role in the Global Marketplace

The Importance of International Trade to Alaska's Economy

By: Greg Wolf, Executive Director, World Trade Center Alaska

February 10, 2009, Juneau, AK

Presented to:

- House Special Committee on Economic Development, Trade and Tourism
- Senate Special Committee on Trade, Technology and Innovation

WORLD TRADE CENTER ALASKA

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International Trade is Big Business for Alaska

- Annual Worldwide Exports totaled some $3.7 billion in 2008

<u>This represented:</u>

- Nearly 10% of the Alaska's Gross State Product (GSP)
- New Money into Economy
- Thousands of Direct and Indirect Jobs

<u>Results in:</u>

- Stronger, More diversified Economy

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Why Trade Matters

- Substantial component of Alaska's economy. Exports account for approximately 10% of the GSP. Export total does not include the export of services from Alaska—such as construction, engineering and oil and gas services.
- Exports bring nearly $4 billion of new money into our economy. New money, not recycled money.
- Export jobs are high paying jobs. Export-related jobs typically pay 13 to 16% more than jobs tied solely to domestic economy.
- Exports allow companies to become larger through expanded markets and customer base.
- For some Alaska companies, their best bet for growth is overseas markets.

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How Does Alaska Rank?

- Alaska is one of the most trade-oriented states in America:
- In absolute terms, at $4.0 billion, Alaska ranks 42nd among all states
- On a per-capita basis, Alaska ranks 4th
- Exports as a percentage of Gross State Product (GSP), Alaska ranks 8th in the nation
- Foreign direct investment: Alaska ranks 8th in attracting overseas investment ($31 billion cumulative)

(*rankings based on full year 2007 results)

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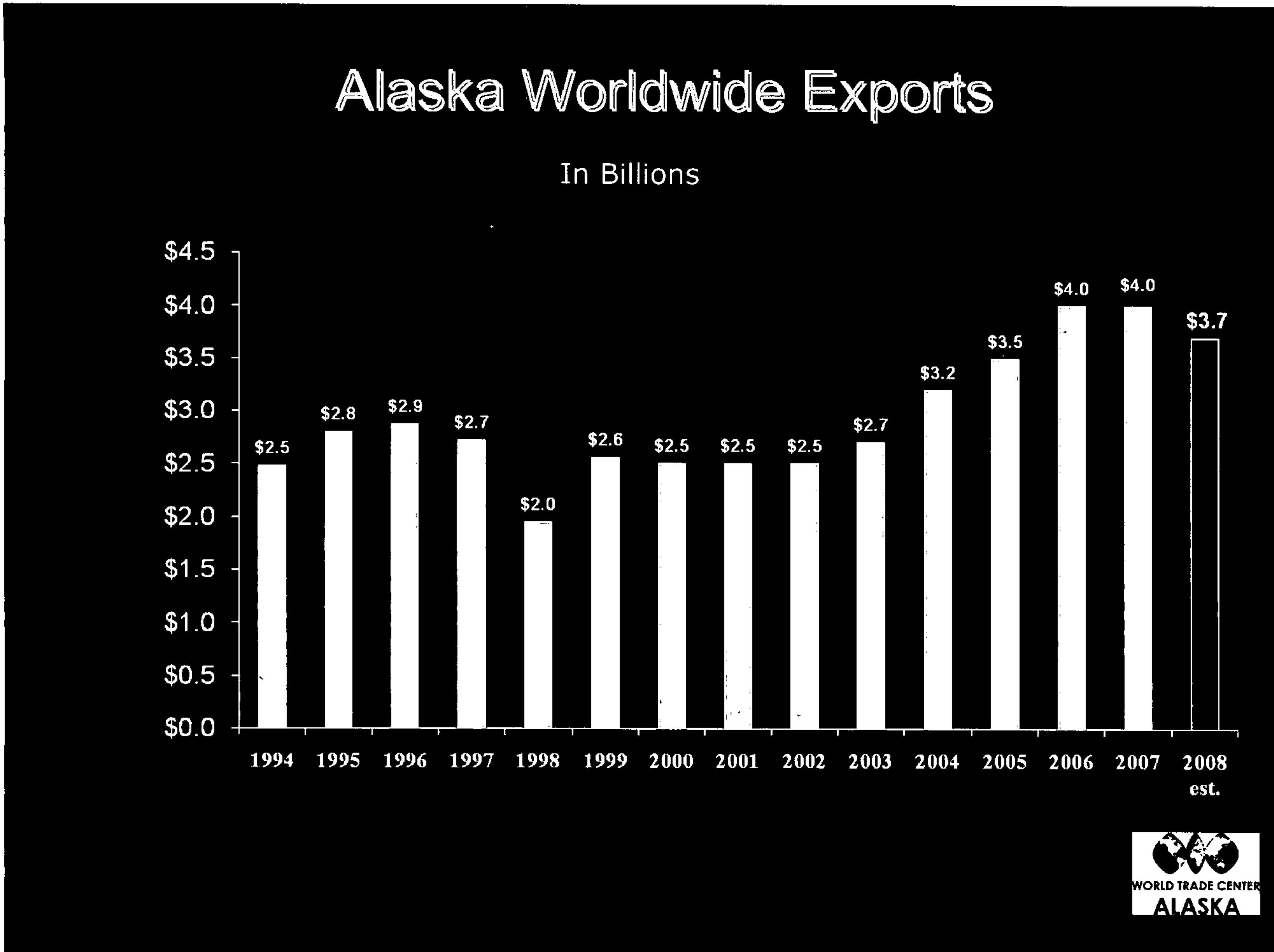
Alaska Worldwide Exports
In Billions
$4.5
$4.0
$3.5
$3.0
$2.5
$2.0
$1.5
$1.0
$0.5
$0.0
$2.5
$2.8
$2.9
$2.7
$2.0
$2.6
$2.5
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ALASKA


Alaska's Top Ten Export Markets 2008
January - September 2008
Others, 10%
Belgium, 1%
Portugal, 2%
Taiwan, 2%
Netherlands, 3%
Switzerland, 4%
Germany, 7%
Canada, 10%
Korean Republic, 11%
Japan, 28%
China, 22%
Source: U.S. Census Bureau, SOA, Governor's Office of International Trade
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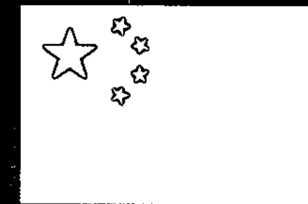
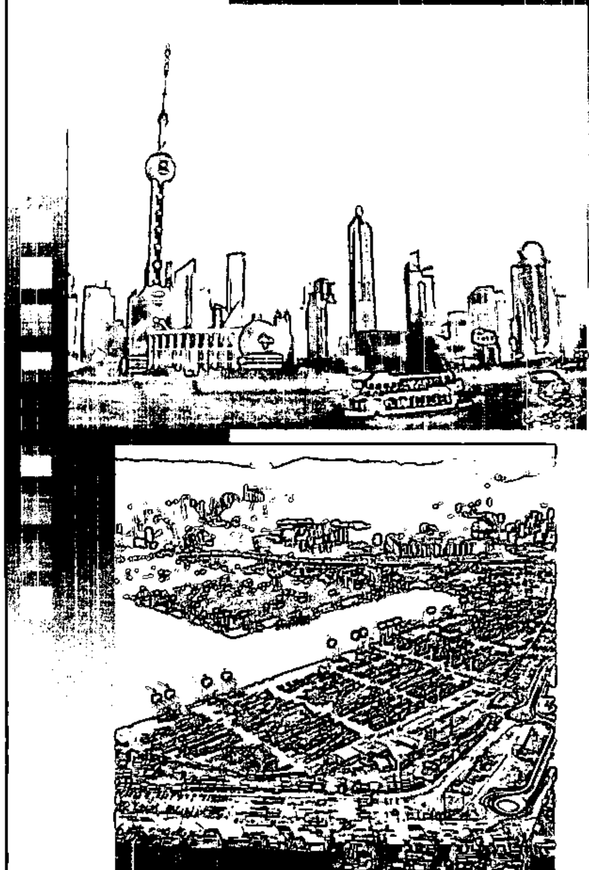
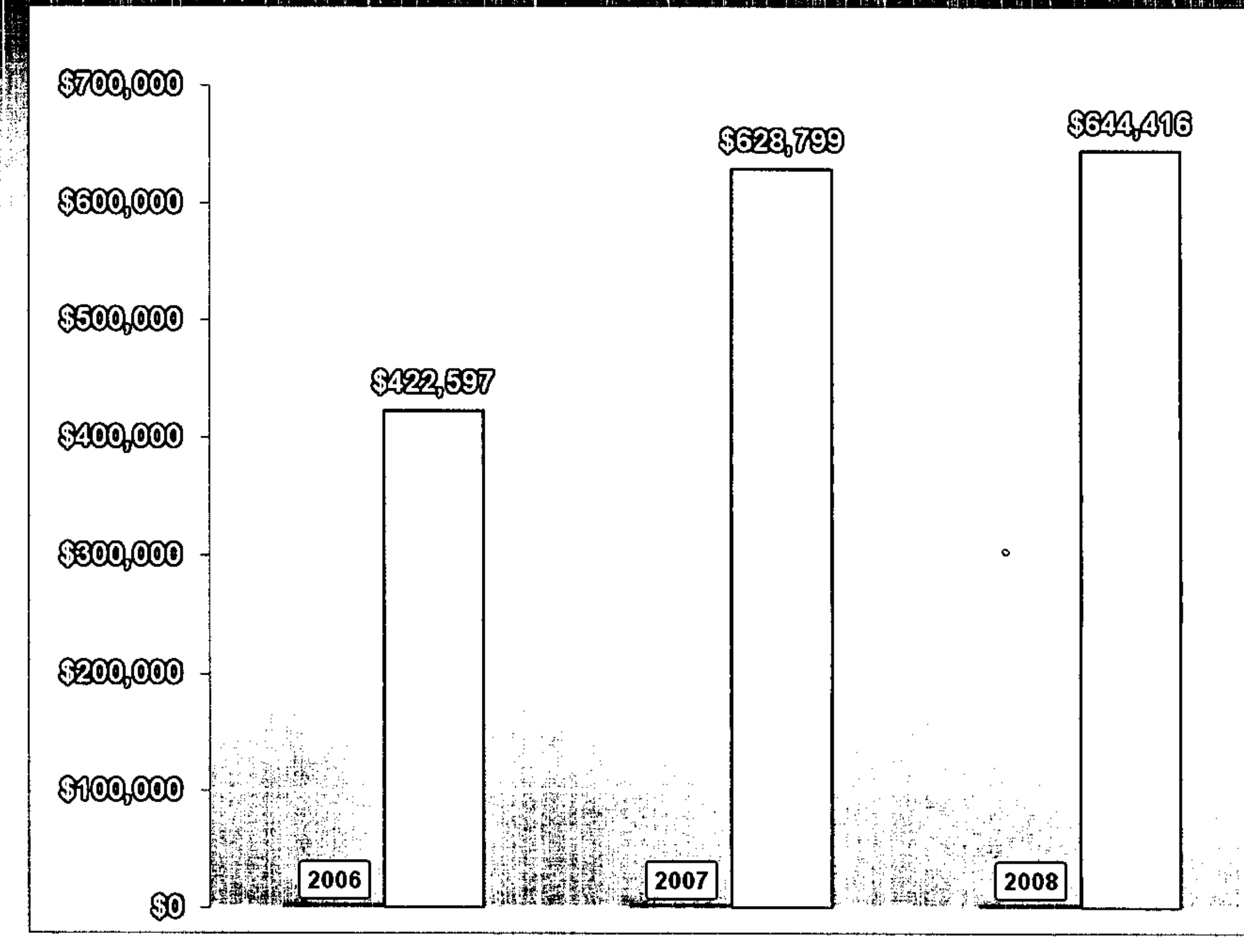
ALASKA

Alaska's Total Exports to China
2006-2008 Comparison (millions of USD)
January – September







Source: U.S. Census Bureau, SOA, Governor's Office of International Trade

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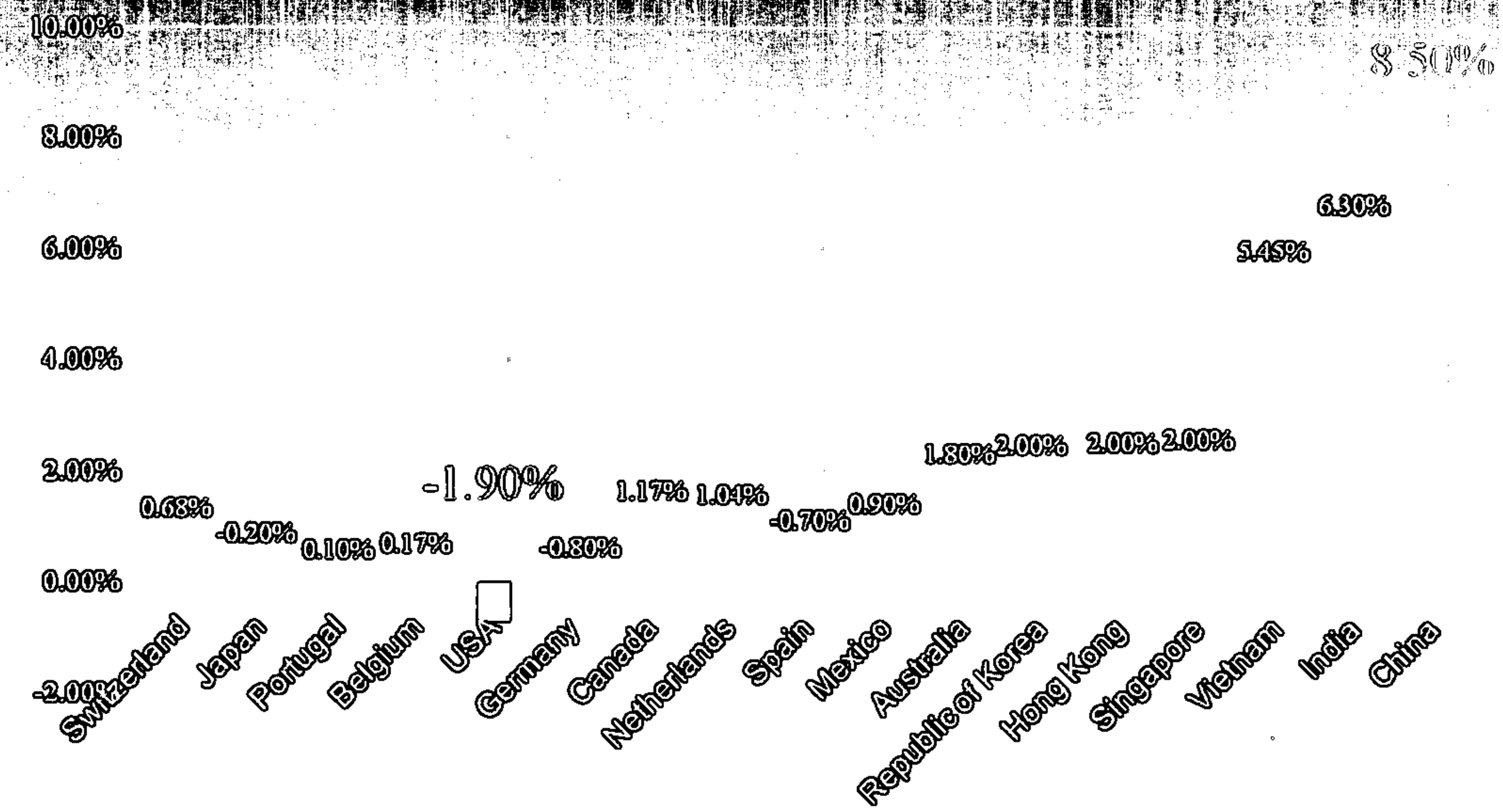
Greater Economic Growth Overseas in 2009



Source: International Monetary Fund Projection (*as of November 2008*)

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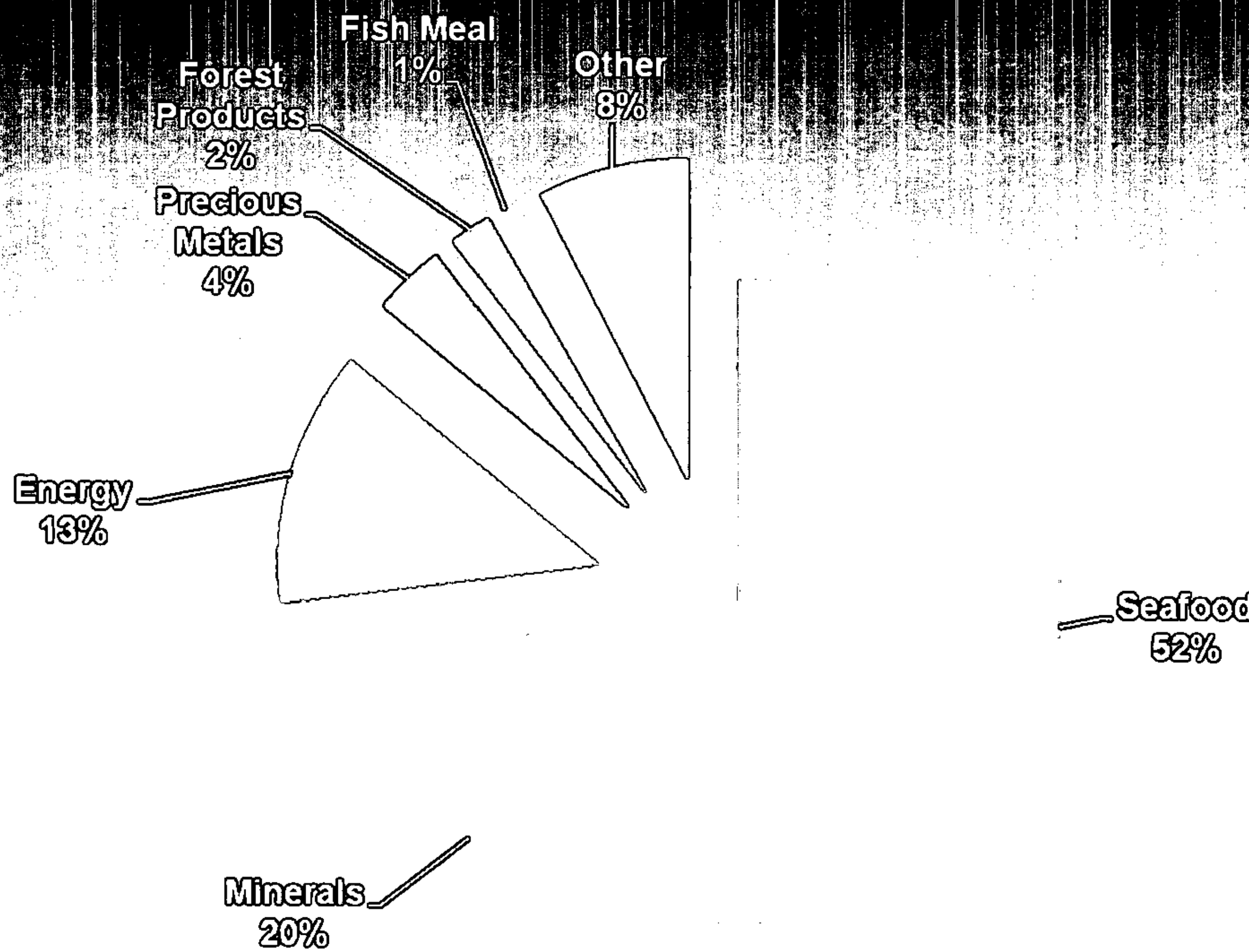
Alaska's Top Export Products 2008

January –September 2008



Source : US Census Bureau, State of Origin data

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Alaska's Service Sector Exports

- Revenues difficult to calculate—USDOC does not record and report service exports as they do commodity exports

- WTCAK estimate is $500 to $750 million annually—probably understates actual total

- Service sector exports from Alaska include: oil and gas field services, construction, engineering, transportation and logistics, architecture and environmental services

- Countries where Alaska companies have provided services include: Canada, Russia, Taiwan, China, Korea, Middle East, and others

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Why Alaska Companies?

- Alaskans firms have developed world-class capabilities and are now finding customers overseas
- Alaskan firms have gained experience and expertise in carrying out projects in remote locations, with extended supply chain challenges, in often-harsh weather/climactic conditions, under stringent environmental regimes, and lack of local trained labor and suppliers
- Relationships with multi-national companies create opportunities outside of Alaska
- These skill sets, experiences, and relationships can translate to other similar regions (e.g. Canada, Russia) and to non-similar regions (Middle East, Africa, etc)

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2009 Trade Outlook

- Results will depend heavily on commodity prices-minerals and metals, and value of seafood catch
- Effect of U.S. economic slowdown on Asian exporting countries—which are among Alaska's best customers—will strongly impact Alaska's exports in '09
- Watch the dollar--a weaker dollar makes U.S. exports relatively cheaper
- Loss of fertilizer's exports with Agrium closure
- Exports slightly down in 2009
- 2009 Forecast: $3.5 to 3.6 billion—down, but still near upper range of results during past 15 years

WORLD TRADE CENTER ALASKA

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Mission

On behalf of members and community partners, the mission of World Trade Center Alaska is to assist Alaskans to successfully compete for trade and investment in the global market place.

WORLD TRADE CENTER ALASKA

Core Functions

- Trade Capacity
- Trade Development
- Trade Service
- Trade Facility
- Trade Network

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ALASKA

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Activities & Programs

- One-on-one trade counseling
- Market research
- Conferences, seminars, monthly luncheons
- Trade missions

WORLD TRADE CENTER ALASKA

Serving Alaska's Business Community Since 1987

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twenty-years

Phone: (907) 278-7233

Fax: (907) 278-2982

Email: info@wtcak.org

2-18-09 Workforce Development in Alaska

<target><bill></bill><subject>2-18-09   Workforce Development in Alaska</subject><comm>SWTR26</comm></target>

1204

STATE OF ALASKA

Department of Education & Early Development

Office of the Commissioner

SARAH PALIN, GOVERNOR

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801 West Tenth Street, Suite 200
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Juneau, Alaska 99811-0500
(907) 465-2800
(907) 465-4156 Fax

Presentation by Commissioner Larry LeDoux

Senate Special Committee on World Trade, Technology & Innovation
Senator Lesil McGuire, Chair

Wednesday, February 18, 2009, Alaska Capitol Butrovich Room 205

Senate Bill 31
Alternative & Renewable Energy Production Tax Credit

<u>Preparing Alaskans for jobs and careers in emerging alternative energy technologies</u>

Career & Technical Education (CTE) in Alaska's secondary schools

Technological advances and global competition have transformed the nature of work. Tomorrow's jobs will require more knowledge, better skills, and more flexible workers than ever before. Current CTE programs incorporate rigorous academic, technical and employability skills so tomorrow's workers can continually update their knowledge and skills and be prepared to change jobs and careers several times. Career clusters identify educational pathways from secondary school to postsecondary education in apprenticeship, technical schools, two- and four-year colleges, graduate school, and the workplace.

What CTE programs were available to secondary students in 2007-2008?

Federal Perkins' grantees reported 16,620 non-duplicated CTE "participants" in grades 9-12 (i.e. enrolled in a CTE course that addressed industry and academic standards) and 933 CTE "concentrators" (earned 2 or more credits in the same pathway *and* graduated that reporting year). Included in these numbers are 2,825 students who took a Tech Prep CTE course and earned postsecondary credits or advance points toward a future apprenticeship program. Enrollment in the career clusters most closely associated with alternative energy technologies were:

# non-dup. participants	# graduated concentrators	Career Clusters (and example programs)
2578	157	Construction (includes drafting & building projects)
1068	112	Transportation, Distribution & Logistics (auto repair, small engines)
1049	47	Manufacturing (i.e. welding boats & trailers, woodworking)
739	27	Scientific & Technical Services (STEM, Project Lead the Way)
665	42	Agriculture & Natural Resources (fisheries, horticulture)
653	34	Information Technology (networking, A+ & Cisco)

Alternative Energy Program Notes

Alternative energy issues, strategies, techniques, and practices represent a significant opportunity for upgrading CTE programs through industry partnerships, collaborative curriculum revision, teacher training and internships. Current practice, however, is not systematic and usually depends on the initiative of the individual teacher. Some anecdotal examples:

- Sitka Education Consortium – energy efficient remodeling and weatherization (federal YouthBuild and HUD funding)
- Bristol Bay High School – rebuilding a VW bus to be energy-efficient http://www.alaskabug.blogspot.com/
- Mat-Su home construction program emphasized energy efficient windows and mold prevention
- Nome JROTC incorporated Young Engineers' program
- Cordova Energy Center: The mission of the Cordova Energy Center is: To use the resources of our community, our natural surroundings, and sound scientific research to develop an interactive website that offers useful information regarding energy efficiency, and allows for on line collaboration and documentation of alternative energy projects. cordovaenergycenter.org

Potential exists for programs with significant interest in alternative energy:

- Project Lead the Way is a national STEM (science, technology, engineering & math) program with prescribed curriculum and teacher training leading to postsecondary education. Dimond (Anchorage), Lathrop (Fairbanks), Mat-Su Career & Technical (Wasilla) and Juneau Douglas (Juneau) high schools are developing the pre-engineering programs. At this time the approved curriculum is not focused on alternative energy or "green" issues, but teachers may incorporate their own project ideas as the applied component (e.g. Mat-Su students designed a glass sorter for use in recycling.)

1206

- Nome and Bering Strait would like to develop a program to support operation of the local wind generators, but to date haven't been successful in winning funds or technical assistance.
- The Construction Academies represent an opportunity to make a large number of beginning construction students aware of "green" issues and practices in the construction industry.
- There are postsecondary programs with the potential for secondary/postsecondary program articulation and technical assistance at AVTEC and UAF's Alaska Center for Energy and Power.

<u>How is CTE delivered to secondary students in AK?</u>

- Most secondary CTE is delivered through the efforts of 172 comprehensive high schools and their staff. Creative delivery strategies are quite common, however, to expand the offerings available to students by taking advantage of instruction from non-school sources. These include local experts, distance delivery, on-site short term intensive courses taught by itinerants, buying "seats" in college or adult courses (e.g. ETT course offered by the local fire department).
- Specialized CTE schools or programs have been established. They include:
    - Magnet CTE high schools (students enroll full-time)
        - Hutchison Technical High School – Fairbanks
        - Mat-Su Career & Technical High School – Wasilla
    - Career-focused programs (students stay enrolled in home high school)
        - King Career Center – Anchorage
        - Mat-Su District-wide Programs – Mat-Su School District
        - NACTEC – Bering Strait and Nome School Districts
        - Construction Academies – Anchorage, Fairbanks, Mat-Su, Kenai, Juneau, Ketchikan
    - Boarding Schools have a CTE component for interested students
        - Galena Interior Learning Academy (GILA) – Galena
        - Nenana Living Center – Nenana
        - Mt. Edgecumbe - Sitka
    - Funding-dependent programs (Topic depends on winning competitive funding)
        - Sitka Career Consortium – Sitka
        - Yuut Elitnaurviat – Bethel
        - SERRC – Juneau

CTE and WFD (WorkForce Development) Advisory and Advocacy Groups currently in AK – Feb. 2009

Title	Sponsorship	Why it exists	Representation	Our take
AWIB - Alaska Workforce Investment Board --Standing Committees • Executive • Policy & Planning / Assessment & Evaluation • Workforce Readiness and Employment & Placement • Legislative • Youth Council http://labor.state.ak.us/awib/	AK Department of Labor	AWIB "provides policy oversight of state and federally funded job training and vocational education programs. AWIB is the policy oversight board for vocational and technical education in Alaska under the federal Workforce Investment Act."	Commissioner of Education (or designee) is statutory member – and is assigned to AWIB's Policy, et.al. Committee. Most members are from private industry. Appointed by Governor. Supports a number of new regional WIBs to work at more local level – ANC, Mat-Su, etc. Helen is EED's designee to Youth Council	Not truly a state-wide, inter-departmental WFD oversight board since moved out of Gov's Ofc. Has influence – not authority - on policy for Univ or EED. Mostly an advisory board for DOL's WIA (Workforce Investment Act) programs that emphasize short-term training for adults and out-of-school youth (especially dropouts). AWIB wants schools to teach/assess SCANS skills (see resolution. G:\Perkins\ Collaborations\AWIB
APICC - Alaska Process Industry Careers Consortium http://www.apicc.org/	Industry supports, plus seek grants for projects & initiatives (usually DOLWD)	"APICC has been, and continues to be, at the forefront in connecting the workforce development needs of processes industries with Alaskan secondary education and post-secondary educational institutions. We plan on not only being full participants, but leading the way in industry driven data, needs, standards and curriculum to meet present and future workforce challenges."	industry, education, labor, and trade leader building partnerships for workforce development in the oil, gas, mining, power, and other process industries in Alaska	10 year history of developing and supporting programs for process industry technicians that are truly seamless across UA campuses. Support K-12 efforts with: TIE - Teacher Industry Externships and YES – Youth Employability Skills standards

CTE and WFD (WorkForce Development) Advisory and Advocacy Groups currently in AK – Feb. 2009

Title	Sponsorship	Why it exists	Representation	Our take
PARW - Putting Alaska's Resources to Work http://www.parw.info/download/PARW_PLAN_FINAL_2.pdf	APICC related industries plus mining interests	Industry-led, evolving and broad based alliance of oil, gas and mining industries and workforce development organizations working together to ensure Alaska will have a highly skilled and globally competitive workforce that meets the current and future needs of Alaska's process industries. They are attempting to implement their plan (see website)	Alaska Chamber of Commerce ACSA VTEP Alaska Mineral & Energy Education Fund (AMEREF) Alaska Miners Association (AMA) Alaska Oil & Gas Association AKPTA APICC Alaska Trucking Association, Inc. Anchorage Economic Development Corporation AASB Alaska Association for Career and Technical Education Association of General Contractors of Alaska (AGC) Resource Development Council for Alaska, Inc. The Alaska Support Industry Alliance University of Alaska EED	PARW has held state conferences to create awareness of its issues, and is now trying to build momentum through committee work. Many of this group's on-going activities are being held jointly with APICC. It may be evolving into a part of the APICC (a lot of overlap in membership and staff support)
ABEC Alaska Business Education Compact	Started in old School to Work program days; now kept going by industry and educator interest	To prepare our youth, we need a coherent system that connects employers, educators, parents, community members and students. This system must be locally driven by parents and the private sector. Members of the Alaska Business Education Compact unite to build and sustain this system to successfully prepare our youth for their futures.	"We are employers, educators and community members who work together to ensure all Alaska's youth are prepared for work and lifelong learning." Active members include Dave Rees (chair), Sarah Scanlan-First Alaskans Inst, Mary Shields (business), UA personnel and some district CTE coordinators; Helen regularly attends the	This group is primarily networking, although they have attempted to develop program ideas and find someone else to implement (i.e. apply for grants). In the past couple years, these have included replicating an OR model for students to earn "employability credentials" through series of job shadowing experiences, and conducting long-term (5 yr) follow-up of AK

CTE and WFD (WorkForce Development) Advisory and Advocacy Groups currently in AK – Feb. 2009

Title	Sponsorship	Why it exists	Representation	Our take
			meetings. Mtg notes go to large email list.	students to see how they fare in ed. and employment.
VTEP - Vocational Technical Education Providers www.vtep-alaska.org/	Self-interested networking at this point, although originally established by DOL/AWIB to create a progress report "Building a Statewide System"	VTEP members work cooperatively to advance a more integrated and effective vocational education and career training system in the State of Alaska; as of May, 2008 are part of the AWIB's Workforce Readiness/Employment & Placement Committee.	VTEP as a membership organization is guided by a memorandum of understanding signed by affiliated members who commonly seek a quality CTE program in Alaska that is: needs-driven, accessible to all Alaskans, interconnected, accountable, collaborative, and sustainable.	This group waxes and wanes in activity, although they meet via teleconference fairly regularly to communicate. They were instrumental in developing the original proposal for the state tech-prep consortium that works with districts and postsecondary statewide (and bridges the 3 University MAU's)
AACTE - Alaska Association for Career & Technical Education www.actealaska.org	Professional organization affiliated with national ACTE (Association for Career and Technical Education)	AACTE is the professional organization for Alaskan career & technical education (CTE) teachers and anyone interested in promoting and strengthening CTE programs in our state.	Primarily secondary CTE teachers, some postsecondary personnel	Collaborate with EED to support professional development related to CTE pathways.
AKCIS - Alaska Career Information System Advisory Board www.akcis.org	Alaska Commission on Postsecondary Education & DOL	Advise AKCIS about recommended improvements to its services	Invited AKCIS users, plus DOL and EED staff	The sponsorship of ACPE has provided new energy to this useful product.
Alaska Construction Academy Advisory Board http://www.alaskaca.org/servlet/content/advisory_board_.html	Alaska Construction Foundation (and Alaska General Constractors)	Advisory Board meets a couple times a year to provide advice or feedback on features, organization, etc. of AKCIS website	EED Commissioner is a Board member, plus Esther Cox Alaska General Contractors Alaska Works and union representatives, legislators	Construction academies began as DOL Youth First project, picked up and advocated with legis. by the AGC Kathleen Castle, Esther's daughter-in-law is the Executive Director
CTSO - Career and Technical Student	EED/CTE and involved school districts and (usually	This is a historical part of CTE programs, used to	BPA- Business Professionals of America	Exists in AK because of commitment of local

CTE and WFD (WorkForce Development) Advisory and Advocacy Groups currently in AK – Feb. 2009

Title	Sponsorship	Why it exists	Representation	Our take
Organizations http://www.ctsoalaska.org	volunteer personnel)	teach employability skills such as teamwork, social skills, leadership and also assess technical skills through competitive events. All supported organizations are connected to a national organization.	DECA- An Association of Marketing Students; FCCLA- Family, Career, and Community Leaders of America FFA- Agricultural Education HOSA- Health Occupations Students of America Skills USA	teachers who serve as state advisors. EED supports state-level coordination and events with a small grant
Alaska Tech Prep Consortium Advisory Board www.alaska.edu/techprep/index.html	UAA	Provide policy advice and oversight to Alaska Tech Prep programs that connect high school and college instruction and/or apprenticeship programs to prepare students for technical careers in fields with strong employment growth and earnings potential.	"The active governing board consisting of skilled and experienced secondary and postsecondary educators, business and industry representatives."	This board is connected to Perkins' grant, but attempts to involve broader players in tech-prep-like activities from other campuses. Fred Villa has been actively involved as he attempts to coordinate CTE programs across campuses.

RESOLUTION NUMBER 08-02
RESOLUTION IN SUPPORT OF POLICY TO ENSURE
EMPLOYABILITY SKILL STANDARDS AND ASSESSMENTS

WHEREAS, the Alaska Workforce Investment Board is a private industry driven public organization that is accountable through its members and staff, including representatives from business and industry, education, and organized labor to the residents, the Legislature and the Governor of Alaska;

WHEREAS, the Alaska Workforce Investment Board acts as the lead state planning and coordinating entity for state human resource programs involving employment training, vocational education, and workforce development;

WHEREAS, the partnership between the Department of Labor and Workforce Development and the Department of Education and Early Development, under regulations adopted by the State Board of Education and Early Development are a first step to ensure that students in Alaska have basic transitional skills for post-secondary training and education and entry to the workplace;

WHEREAS, existing regulations do not incorporate adequate employability skill standards and assessments;

NOW THEREFORE BE IT RESOLVED that the Alaska Workforce Investment Board officially supports regulations to ensure *employability skill standards and assessments* into Alaska's secondary schools, youth training programs and post-secondary training institutions to ensure Alaska's youth have work-readiness skills.

CERTIFICATION
The Alaska Workforce Investment Board held a meeting duly and regularly called, noticed, and convened this 21st day of May, 2008 and the foregoing Resolution was adopted unanimously at said meeting.

Signed this 21st day of May 2008.

Andy Baker

Andy Baker, Chair
Alaska Workforce Investment Board

Career Cluster Name	Description	Career Cluster Name	Description
Agriculture, Food & Natural Resources	The production, processing, marketing, distribution, financing, and development of agricultural commodities and resources including food, fiber, wood products, natural resources, horticulture, and other plant and animal products/resources.	Hospitality & Tourism	Hospitality & Tourism encompasses the management, marketing and operations of restaurants and other foodservices, lodging, attractions, recreation events and travel related services.
Architecture & Construction	Careers in designing, planning, managing, building and maintaining the built environment.	Human Services	Preparing individuals for employment in career pathways that relate to families and human needs.
Arts, Audio/Video Technology & Communications	Designing, producing, exhibiting, performing, writing, and publishing multimedia content including visual and performing arts and design, journalism, and entertainment services.	Information Technology	Building Linkages in IT Occupations Framework: For Entry Level, Technical, and Professional Careers Related to the Design, Development, Support and Management of Hardware, Software, Multimedia, and Systems Integration Services.
Business, Management & Administration	Business, Management and Administration careers encompass planning, organizing, directing and evaluating business functions essential to efficient and productive business operations. Business Management and Administration career opportunities are available in every sector of the economy.	Law, Public Safety & Security	Planning, managing, and providing legal, public safety, protective services and homeland security, including professional and technical support services.
Education & Training	Planning, managing and providing education and training services, and related learning support services.	Manufacturing	Planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance and manufacturing/process engineering
Finance	Planning, services for financial and investment planning, banking, insurance, and business financial management.	Marketing, Sales & Service	Planning, managing, and performing marketing activities to reach organizational objectives.
Government & Public Administration	Executing governmental functions to include Governance; National Security; Foreign Service; Planning; Revenue and Taxation; Regulation; and Management and Administration at the local, state, and federal levels.	Science, Technology, Engineering & Mathematics	Planning, managing, and providing scientific research and professional and technical services (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.
Health Science	Planning, managing, and providing therapeutic services, diagnostic services, health informatics, support services, and biotechnology research and development.	Transportation, Distribution & Logistics	Planning, management, and movement of people, materials, and goods by road, pipeline, air, rail and water and related professional and technical support services such as transportation infrastructure planning and management, logistics services, mobile equipment and facility maintenance.

CORDOVA ENERGY CENTER

WELCOME
To the Cordova Energy Center

If you want some basic information check out the projects and about us pages. If want to get in on the action or see what the latest news is cruise on over to the forums!

Jim Jarvis and Bruce Cain

Upcoming Events

October

- **8** Class meets with Jim Jarvis.
- **10** Wind turbine is installed.
- **21** Anemometer installed above resevior.

November

- **8** Ben and Grafton give speech to Alaska School Board

Recent Forum Topics:

- Home Energy Audit

  Statistics : Posted by Adam Low • on Mon Oct 27, 2008 4:58 am • Replies 8 • Views 101

- Boat Heating?

  Statistics : Posted by Darin • on Fri Nov 07, 2008 11:14 pm • Replies 1 • Views 33

- Update on Wind Data

Statistics : Posted by Drew • on Wed Nov 12, 2008 5:30 am • Replies 2 • Views 28

- Solar Panels

  Statistics : Posted by Adam Low • on Mon Oct 27, 2008 5:25 am • Replies 8 • Views 82

- Rain Gutter Power

  Statistics : Posted by Reuben • on Fri Nov 07, 2008 11:10 pm • Replies 3 • Views 39

- Tidal Power

  Statistics : Posted by Trae • on Tue Oct 28, 2008 10:52 pm • Replies 5 • Views 71

- What other ways can we reduce energy costs?

  Statistics : Posted by Ben Jamm • on Tue Nov 04, 2008 10:18 pm • Replies 3 • Views 63

- Saltwater burning?

  Statistics : Posted by Darin • on Fri Nov 07, 2008 11:17 pm • Replies 0 • Views 39

CORDOVA ENERGY CENTER

Home About Us Forum Projects Contact

About Us

The Cordova Energy Center is founded by the physics class of Cordova High School. Our teacher, Mr. Adam Low, decided that this year he wanted to dramatically change his teaching method and the students agreed to his new, radical concept. We put our textbooks aside and went on to begin solving real world problems in our local community. The reasoning behind this is that one can learn a subject much more effectively if they are doing hands on work with real life meaning. This website was designed and is run by two of the students in order to create a place where the class and others with interest in our endeavors can communicate.

Mission Statement

The mission of the Cordova Energy Center is: *To use the resources of our community, our natural surroundings, and sound scientific research to develop an interactive website that offers useful information regarding energy efficiency, and allows for on line collaboration and documentation of alternative energy projects.*

CORDOVA ENERGY CENTER

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Projects

Welcome to the projects page. Here we have a list of all the energy related prjects being run by students. We've got many great ideas so check them out. If you'd like to get involved or just send a comment check the Contact page and throw us an email.

Wind Power

One group of students are developing a wind feasibility study and will soon be installing a wind generator at the highschool.

learn more

Conservation

Another group is looking into energy conservation techniques and will be doing energy audits later in the year.

learn more

About this Project

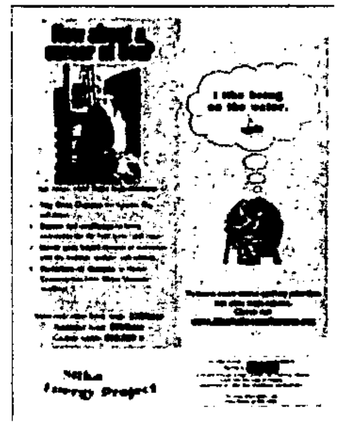
About the Alaska Energy Careers site

In Spring 2006, Sitka Works was awarded a High Growth Job Training Initiative grant through the Alaska Department of Labor and Workforce Development, to fund the *Sitka Energy Project.* **The main goal of this six-month project is to raise awareness, and educate Sitka's high school students, their teachers, and parents about the exciting jobs available in energy-related industries such as construction, mining, oil and gas, and transportation.**

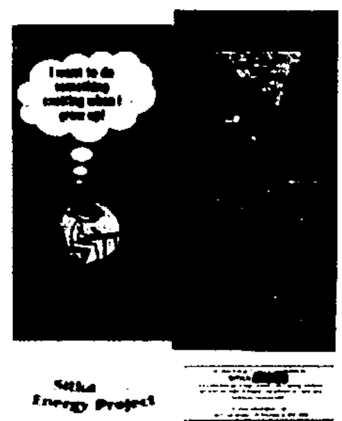
There are several components to our project, with objectives that include:

- **Developing a network of representatives of high growth industries and statewide training entities** who are willing and able to participate in educating Sitka's students, teachers and parents. Students at all three high schools will be impacted – Sitka High School, Mt. Edgecumbe High School and Pacific High School.
- **Increasing awareness of energy careers** - through posters at the high schools, the *Sitka Energy Project* website, presentations by industry and training representatives at the high schools, presentations by project staff at public meetings, interviews on radio and television, and personal contacts. The website is designed as a steppingstone for Sitka youth – launching them from the familiar to the unknown. It features young people who graduated from one of our local schools and then went on to enter a career in an energy industry.
- **Educating high school youth about energy careers** - through the Energy Career Camp for MEHS students (August 20-26), classroom visits by industry and training representatives, an Energy Night, a tour of Juneau energy facilities for Pacific High School students, a new AutoCAD class at Sitka High School in spring 2007, and work experiences, job shadowing, or mentorships with local experts.
- **Educating high school teachers and counselors** – through classroom visits by industry and training representatives, a 3-day tour of energy facilities in Anchorage for four Sitka High teachers, and AutoCAD training for two SHS teachers.
- **Developing new energy-related curriculum** for high schools students as a result of the AutoCAD training and the Anchorage tour.

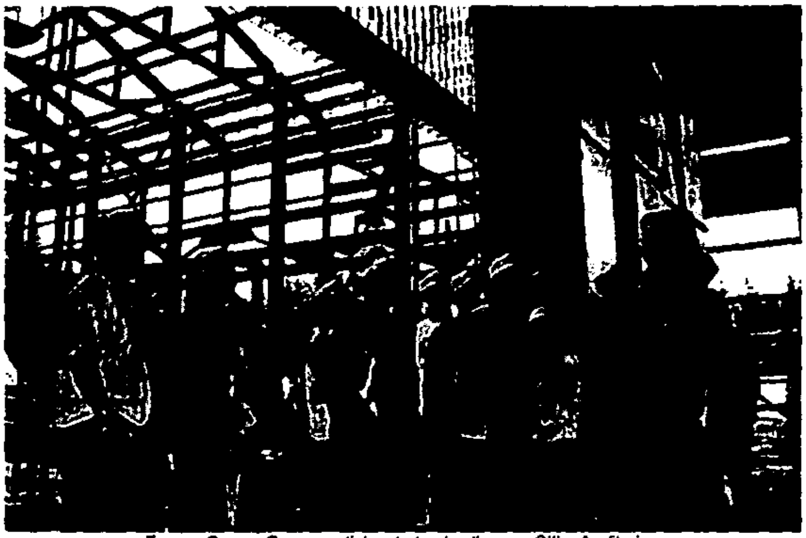
Related Links



Download Ian's poster (PDF)



Download Meredith's poster (PDF)



Energy Career Camp participants touring the new Sitka Auditorium

Who's Responsible?

By Sheila Finkenbinder, Director
Sitka Works!

We've heard a lot about energy in the news lately. Here in Sitka, it only takes a bird to stop the electricity from traveling from the hydroelectric plant into our computers, lights, cash registers, stoves - all the things we count on to get our jobs done and keep our lives running smoothly. Further away, it only takes a little sand, salt, or bacteria to corrode the massive pipelines that carry oil from Prudhoe Bay to the rest of the country. If the oil stops, the ramifications to the nation's economy are huge.

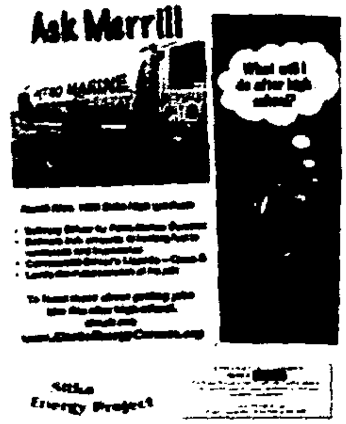
How quickly the supply of energy can be threatened or shut off, and we are all inconvenienced by the lack of power to run our lives. Most of us sit by and wait for someone else to fix the problem. Depending on the severity of the situation, we may just relax instead of working on a report, we may holler and blame, or we may actively look for ways to save the lives that are threatened by the situation. But, most of us don't do anything to fix the situation.

However, there are a bunch of folks who spend their days making sure that energy supplies are available and affordable for all of us to use. These individuals could be considered some of today's heroes. These are the men and women who don't mind doing dirty, and sometimes dangerous things, on a daily basis, so that we can all live comfortably and worry-free. In fact, most of them really enjoy their jobs.

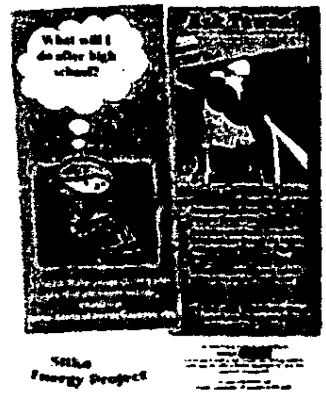
The Sitka Energy Project, at Sitka Works, has a mission of raising the awareness among Sitka's high school students, as well as their parents and teachers, of the many jobs in energy-related industries that can be exciting, critically important, and often financially rewarding.

The young lady in the photo is a Corrosion Engineer with Alyeska Pipeline Service Company. Her name is Tawna Beer, and she is a 1998 Sitka High School graduate. With a Bachelor of Science degree and several certifications through the National Association of Corrosion Engineers (NACE), Tawna has a challenging and rewarding career that is critical to the nation's power supply and economy. Most of her training has been in the field and on the job. An entry-level position like hers could pay at least $50,000 annually, with "lots of opportunity to grow at a fast pace", as Tawna stated.

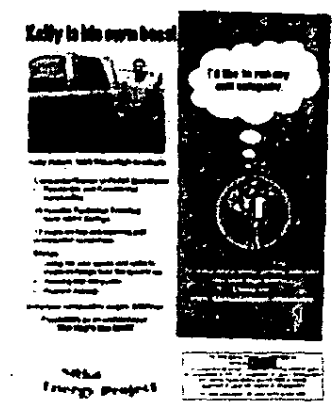
Many very good jobs in energy-related industries do not require college degrees. These could include jobs in construction, mining, oil and gas, transportation, and yes, hydroelectric and other alternative sources of energy. As a matter of fact, many of the folks who work at things like building, installing, repairing, exploring, processing, or transporting, got those jobs through short-term training and



Download Merrill's poster (PDF)



Download Tawna's poster (PDF)



Download Kelly's poster (PDF)

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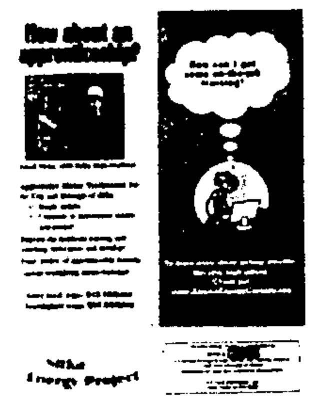
on-the-job experience. The salaries that people working in the trades earn often rival, or often surpass, those earned by many college graduates. Please understand, there's nothing wrong with getting a college education. In fact, it can often move you further up the ladder, faster, depending on your career area. However, a college degree also comes with a heavy price tag, in the form of student loans that can take years to pay back. Alternatively, many types of technical, hands-on training in the trades can pay off for a young person in a hurry.

Over the next few months, we will be encouraging Sitka's high school students to explore some of the rich variety of jobs that are available in energy industries, many of which can be achieved even if the student isn't ready, willing or able to attend college right away. We hope that the parents of those students will be listening too.



Download David's poster (PDF)

Sitka Energy Project

On-going support for Alaska Energy Careers is provided by bp - committed to Alaska's next generation of workers.

This project was funded by a grant awarded under the President's High Growth Job Training Initiative, as implemented by the U.S. Department of Labor's Employment and Training Administration and the State of Alaska, Department of Labor and Workforce Development.
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1221

Course Name: Architectural Design
Adapted from:
Date: December, 2004

District Name: Kodiak Island Borough School District
Developed by: Barry Altenhof

EED USE ONLY | Date:
Approval Status:

- **Prerequisite Course(s): C or better in Drafting II, Senior status**
- **High School Credit =** 1 **(Postsecondary credit =** 4 **)**
- **This course will be offered:** [X] every year? **OR** [ ] every other year?
- **Pathway** (Optional): Industrial Engineering & Technology
- **Career Cluster Area:** Architecture & Construction
- **Eligibility for Nationally Recognized Skill Certificate(s)/State License?** [ ] **No** **OR** [X] **Yes**

If Yes, identify Certificate(s): AutoCAD certification, www.brainbench.com Drafting certification, www.adda.org

- **Tech Prep:** [ ] **No** **OR** [X] **Yes**

If Yes, (1) List Postsecondary Institution Kodiak College, Kodiak, Alaska

(2) Name of Course AET 101,Fundamentals of CAD for building construction. And the number of postsecondary credits 4

- **Is this course brokered through another institution or agency?** [X] **No** **OR** [ ] **Yes**

If Yes list institution/agency:

- **Course Description:**

Architectural design is an advanced program aimed at developing a broader understanding of the architectural design process. Students will study the history of architecture as well as the lives of important architects and their theories of design. Traditional drafting skills as well as autocad design software will be used to expand on skills learned in Drafting I & II. In particular, students will be asked to design architectural solutions to specific design problems involving alternative energy, public use facilities, use of sustainable materials, and budget limitations. Students also participate in the Frank Maier High School Design Competition.

- **Content Headings/Topics:**

*Career choices related to architectural design skills.
*History of architecture
*Contributions of important 20th Century American architects.
*Cultural value and purpose of architecture.
*Fundamental elements of design.
*Building codes and architectural design.
*Energy efficient design
*Alternative energy sources: solar & wind.
*Schedules and specifications.
*Perform calculations relevant to residential design: load calculations, roof pitch, stair math, and cost estimates.
*Basic architectural materials: concrete, steel, wood.
*Use AutoCAD design software and traditional drafting skills to produce working drawings based on client narrative.
*Second semester senior design project.

Source of Occupational Skills Standards

Source/Organization/Agency	Acronym	Website or location of Information	Section, Chapters referenced in Performance Standards etc

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Course Name: Architectural Design | **District Name:** Kodiak Island Borough School District
Adapted from: | Developed by: Barry Altenhof
Date: December, 2004

EED USE ONLY	Date:
Approval Status:	

National Skill Standards Board	NSSB	www.nssb.org	CAD Standards
American Design Drafting Association	ADDA	www.adda.org	CAD/Drafting Standards

Student Performance Standards (Learner Outcomes)	**Specific Occupational Skills Standards**	**Grade level Expectations in Reading, writing, math**	**Alaska Content Standards**	**Alaska Employability Standards**	**Alaska Cultural Standards**	**All Aspects of Industry**	**Assessments**
Become aware of career opportunities in Architecture		R4.2 W4.1	E—A,B	A,B	D-6	Business Planning	Written Project
Understand architectural history & value of architecture		R4.2,4.3,4.4 4.9 W4.2	T-ALL	A,B	E-4	Business Planning, Tech.Prod, Personal	Written/cad project
Develop an awareness of important 20th century American architects.		R4.2,4.3,4.4 4.9 W4.2	H-ALL				Written/cad project
Assess and use basic elements of design	CADD3.1-3.2	R4.2	T-ALL			Tech.Prod	CAD proj.
Develop a working knowledge of building codes		R4.2		A6		Tech.Prod	CAD proj./ Test
Understand basic concepts and components of solar and wind power generation.	CADD,M1-M8	M5.4.1	M-B,D,E	A,B		Tech.Prod	CAD proj./ Test
Understand key components of energy efficient design		R4.2	S-A			Tech.Prod	CAD proj./ Test
Apply relevant schedules and specifications to projects				A,B		Tech.Prod	CAD proj./ Test
Perform calculations relevant to residential design	CADD,M1-M8	M5.4.1	M-B,D,E	A,B		Tech.Prod	CAD proj./ Test
Learn structural characteristics of concrete, steel, wood		M5.4.1 R4.2	M-ALL			Tech.Prod	CAD proj./ Test
Use autocad software to create residential plans based on specific design criteria.	CADD3.1.2 CADD1.1-1.4 CADD2.1-2.3		T-ALL	A,B		Tech.Prod Bus.Plann. Mgmt.	CAD proj. Design Competition

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Course Name: Architectural Design	**District Name:** Kodiak Island Borough School District	*EED USE ONLY* Date:
Adapted from:	Developed by: Barry Altenhof	Approval Status:
Date: December, 2004		

Student Performance Standards (Learner Outcomes)	Specific Occupational Skills Standards	Grade level Expectations in Reading, writing, math	Alaska Content Standards	Alaska Employability Standards	Alaska Cultural Standards	All Aspects of Industry	Assessments
Create and present a senior design project that incorporates solar and/or wind power into the design.	CADD,C1-C10 C-26 M1-M8 S1,2,8,10	R4.2,4.3,4.4 4.9 W4.2 M2.4.1,3.4.1 5.4.1	T-ALL M-B,D,E	A,B	A,C,E	Business Planning, Tech.Prod Mgmt. Prin.Tech. Finance, Labor	*Project Presentation *Design comp. *Eval.by CT Advisory Bd.

Major Instructional Resources: (websites, textbooks, essential equipment, reference materials, supplies)

Textbook:

Jefferis & Madsen, <u>Architectural Drafting and Design</u>, Delmar, 2004

Reference:

<u>Architectural Graphic Standards</u>, Ramsey & Sleeper, Student Edition, AIA, 1994

Lester Walker, <u>American Homes</u>, Overlook Press, l996

Crowley & Calloway, <u>The Elements of Style</u>, Simon & Schuster, l996

Websites:

http://www.otherpower.com/otherpower_solar.html

http://www.alternative-energy-news.info/technology/solar-power/

www.Autodesk.com **Autodesk, Inc.**

www.nccer.org **National Center for Construction Education Research**

www.adda.org **American Design Drafting Association**

www.nssb.org **National Skill Standards Board**

Course Name: Architectural Design	**District Name:** Kodiak Island Borough School District	*EED USE ONLY*	Date:
Adapted from:	Developed by: Barry Altenhof	Approval Status:	
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www.tenlinks.com **Various links to CAD/technical/design websites.**

Software:

Autodesk Architectural Desktop, 2009

Kodiak High School CAD lab Equipment:

24 Dell Workstations , Windows XP network
HP 5000 Laserjet Printer
HP 800 Inkjet plotter
HP 8275 Computer projector & instructional screen.

Other resources:

Kodiak High School Career Center, Kathy Watkins, Career Pathways Coordinator, 481-2525

Kodiak High School Career Technology Advisory Group-Providing Co-op assistance, scholarships, and material support to Kodiak High School Career Technology programs.

U.S. Department of Energy
Energy Efficiency and Renewable Energy

EERE Home

K-12 Energy Lesson Plans & Activities

Biomass Energy
Energy Basics
Energy Efficiency & Conservation
Environment
Geothermal Energy
Hydrogen & Fuel Cells
Hydropower
Ocean Energy
Solar Energy
Transportation Fuels
Wind Energy
For Grades K-4
For Grades 5-8
For Grades 9-12
Search by Subject & Grade
Contacts

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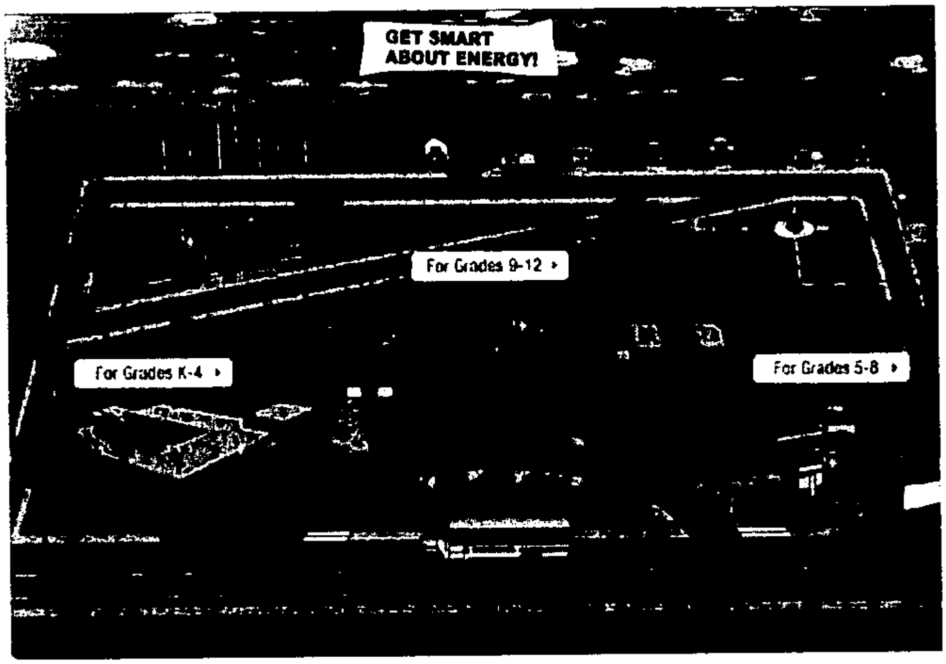
Printable Version EERE Information Center

On this site you'll find links to more than 350 lesson plans and activities on energy efficiency and renewable energy for grades K-12. Each includes a short summary that identifies curriculum integration, time, materials, and national standards. For more education resources, please see the EERE Energy Education Web site.



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Transportation Fuels
Wind Energy
For Grades K-4
For Grades 5-8
For Grades 9-12
Search by Subject & Grade
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Grades 9-12

Here you'll find lesson plans on energy efficiency and renewable energy for grades 9-12.

Biomass Energy

- Biofuel Production (8 Activities)
- The Biofuel Project: Creating Bio-diesel
- A Pre-Treatment Model for Ethanol Production Using a Colorimetric Analysis of Starch Solutions (1 Activity)
- Reaction Rates and Catalysts in Ethanol Production (1 Activity)
- Investigating and Using Biomass Gases
- Photosynthesis and Biomass Growth (7 Activities)
- Renewable Energy Plants in Your Gas Tank: From Photosynthesis to Ethanol (4 Activities)
- Statistical Analysis of Corn Plants and Ethanol Production

Energy Basics

- Energy Posters - Energy Basics
- Secondary Energy Infobook and Secondary Infobook Activities (19 Activities)
- Thermodynamics Teacher and Student Guides (6 Activities)
- Computer-Based Energy Projects (4 Activities)
- Energy Analysis

Energy Efficiency and Conservation

- Take the Energy Action Challenge
- Energy Efficiency Ambassadors (9-12)
- Energy Posters - Energy Efficiency and Conservation
- Energy Walkabout
- New Year's Resolution
- Passive Solar Building Design (8 Activities)
- Summer Camp 2050
- Watt Does It Cost To Use It?

Environment

- Energy Awareness Quiz
- Energy Posters - Environment
- How Big Is Your Footprint?
- Global Warming and Climate Change (8 Activities)

Hydrogen and Fuel Cells

- Hydrogen Sprint (6 Activities)

Solar Energy

- Understanding Solar Energy: Advanced Photovoltaic Investigations (5 Activities)
- Solar Cooking (5 Activities)
- Modeling the Process of Mining Silicon Through a Single Displacement/Redox Reaction
- Mini Rockets
- Photovoltaics: Solar Electricity (4 Activities)
- Photovoltaics Teacher and Student Guides (10 Activities)
- Renewable Energy and Photovoltaics (5 Activities)
- Survival Still
- What Does the Sun Give Us? (5 Activities)

Transportation Fuels

- Transportation Fuels: The Future is Today (6 Activities)
- Transportation Fuels Rock Performances

Wind Energy

- Building the Basic PVC Wind Turbine
- Wind Power (7 Activities)
- Scale Models and Wind Turbines
- See the Wind
- Wind Turbine Blade Design

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EERE Information Center

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Student Energy Competitions and Contests

Here you'll find resources for students of all ages on competitions and contests that promote awareness about energy technologies and issues, including energy efficiency and renewable energy.

American Solar Challenge
University teams, companies, and clubs from around the world build solar-powered cars and race them across the country. Sponsored by the U.S. Department of Energy.

EcoCar Challenge
EcoCAR is a U.S. Department of Energy three-year competition that will challenge university students to re-engineer a Saturn Vue donated by GM, using advanced vehicle technologies to reduce the vehicle's total environmental impact and lead the way to a sustainable transportation future.

Energy Challenge
Teams of college engineering students design energy efficiency and waste minimization concepts that have real applications in the pulp and paper industry.

ExploraVision
A competition administered by the National Science Teachers Association that encourages K-12 students to create technologies-including energy technologies- of the future.

EV Challenge
A competition that educates middle and high school students about innovative electric vehicle technology, as well as its benefits to society.

Foundation for Water and Energy Education: Energize Our Future College Scholarships
College scholarships for five high school students in the northwestern United States who write the best essays about the Northwest's energy future.

Hydro Power Contest
An opportunity for college students to demonstrate their ideas for turning water into power.

Hydrogen and Fuel Cell Competitions for Students and Teachers
Features contests for students in middle school,

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high school, and college.

Igniting Creative Energy Challenge
An educational competition designed to encourage students in K-12 to learn more about energy and the environment.

National Junior Solar Sprint/Hydrogen Fuel Cell Car Competitions
A U.S. Department of Energy program where student teams in grades 6-8 construct model solar and hydrogen fuel cell cars and race them.

National Renewable Energy Laboratory: Student Programs and Competitions
A full range of activities for elementary and secondary school students that provide tutoring, mentoring, science demonstrations, awards and recognition, and more.

National Science Bowl
A U.S. Department of Energy academic competition where teams of high school students answer questions on scientific topics in astronomy, biology, chemistry, mathematics, physics, earth, computer and general science.

Solar Decathlon
A U.S. Department of Energy competition where teams of post-secondary students compete to construct the best energy-efficient, solar-powered houses.

Printable Version

Content Last Updated: 10/09/2008

UNIVERSITY of GUELPH

CHANGING LIVES IMPROVING LIFE

U of G Hosts High School Wind Energy Competition

April 16, 2008 - News Release

It's only fitting that this year's wind energy competition at the University of Guelph will be held on April 22, national Earth Day.

WindENG is an annual event that brings together high school students from across Ontario to test out their energy-generating wind turbine designs and compete for cash prizes.

This year 200 students making up 32 teams will be visiting campus.

Judged by a panel of practicing engineers, the wind turbine designs are tested in the University's wind tunnel, and the top prize will go to the team whose windmill produces the highest average power output. Judges will also consider design functionality, creativity, environmental aspects and presentation.

The first place team will be awarded $2,000, with $1,000 going to the team that places second and $500 to the third place team.

"WindENG helps high school students to connect engineering to design, challenge, fun and important societal needs," said engineering professor Warren Stiver, who is involved in organizing the event. "It also connects socially and environmentally meaningful engineering to the type of engineering that is happening at the University of Guelph."

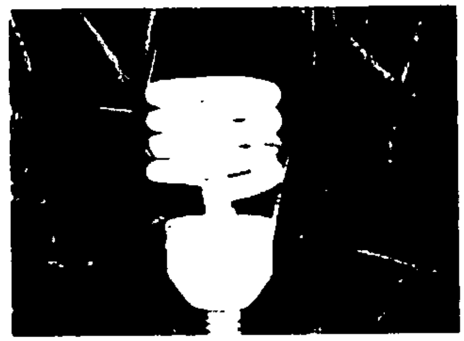
In addition to the competition, high schools students will also attend information sessions on university life and co-op placements. They will hear about U of G's involvement in the BioCar project and participate in interactive workshops.

A variety of displays will be set up as part of the day-long event, featuring Engineers without Borders, the Engineering Society, the Women in Science and Engineering Student Group, and Creative Encounters. There will also be displays highlighting U of G research on solar energy, wind energy, biofilters, rain water harvesting, bioproducts, and water and sanitation in Cambodia.

Students will also have the opportunity to test engineering designs in the activity room and take part in campus tours.

For more information on **WindENG (http://www.windeng.com)** .

2009 Southeast Bio-Energy Competition



The Nationally Environmentally Sound Production Agriculture Lab (NESPAL), in conjunction with the Southeast Bio-Energy Conference Committee has established a competition in four categories: Energy Conservation through Internet monitoring and control systems, Bio-Energy, Other Renewable Energies, and Home and Farm Energy Audits to Promote Energy Conservation. The Southeast Bio-Energy Conference/NESPAL award is intended to encourage the conservation of energy and the development and use of bio-energies.

Two separate competitions will be open to middle school and high school students: junior (grades 6-8) and senior (grades 9-12). Cash prizes of $1,000 will be awarded for first place winners in each of the four categories. There will also be a grand prize for an additional $1,000 for grand prize winner of all categories. The grand prize winner will be given the opportunity to meet with the Georgia Ag Innovation Center for the advancement of their idea and the grand prize winner's idea will be featured in the Future Farmstead. Second place winners will receive a plaque and a photo with Governor Sonny Perdue. In the instance that a team wins, the prize will be divided by the number of participants.

A short youtube video of 2-2.5 minutes should document the process, the reasoning behind the project, and the overall impact the project can have on the community. Each submission will be assessed by a predetermined panel of judges. Each project will be evaluated on resourcefulness, creativity, potential impact, and follow through.

Each team or individual interested is encouraged to write and submit a short synopsis of the project by March 15th. The completed project should be submitted by July 17th, 2009.

Complete Details

Resource Types: Contest/Award

Audience Served: Home Schools, Private Schools, Public Schools, Scouts/Youth Groups

Washington State University

Imagine Tomorrow

How to Compete

Topic and Challenges

Topic

How would you power your future?

As the world transitions to alternate energy sources, people have to make fundamental changes in the way they operate. In this high school energy competition, your team's task is to explore ways to enable some aspect of this transition. What types of inventions or redesigns will be needed to take full advantage of the new energy sources? How will suburbs, towns, and cities need to be redesigned? What types of behavior changes will be necessary, and how do we bring those about?

Challenges

Choose one of these challenges and then create a project that addresses it. Your team may choose to use one of the project examples provided on this Web site, or answer the challenge with your own original idea. The solutions are limited only by your imagination.

Challenge 1. Technology

Invent or re-design a machine or process that uses sustainable technologies for energy production, consumption, and conservation.

PROJECT EXAMPLES

- The front-loading washing machine uses much less water and energy than a conventional washing machine. Identify and re-design the next appliance or machine that will substantially lower energy use in your house.
- On long trips, most current hybrid cars primarily run on the gasoline engine. Determine what changes are required to make plug-in hybrids a viable mechanism for a 200-mile overnight trip.
- One of the challenges for hydrogen cars is the volume required for a storage tank. Identify the top technological innovations that would be required to run a larger vehicle, such as a train or 18-wheeler truck, on hydrogen. Demonstrate a prototype model using one of the key innovations.

Challenge 2. Design

Design a living/working space (a building, suburb, town, or city) that has significantly lower CO_2 emissions than at present.

PROJECT EXAMPLES

- In 2007 the U.S. Green Building Council developed a new set of standards for "green" school construction, and Washington State requires new school construction to meet The Leadership in Energy and Environmental Design (LEED) silver standards. Demonstrate the design of a highly energy efficient high school with a model and schematics.
- Washington State now uses over 1 million gallons of biodiesel a year, and use is growing rapidly. Design a town around a biofuel plant in central Washington that minimizes energy use for the town.
- As cities across the state look at developing new transportation systems, from public transportation to highways, they have to consider many issues. Design a low CO_2 transportation system for a city.

Challenge 3. Behavior

Consider the question of why people are resistant to adopting and implementing alternate sources of energy. Document a personal or social quality that contributes to this resistance, or demonstrate an intervention that can be applied at the personal, local, or societal level to encourage people to consider and adopt alternate

"The energy challenge is both the greatest threat and the greatest opportunity facing humankind in the half-century. Washington State University's *Imagine Tomorrow* high school competition encourages kids across the state to think about and tackle energy issues. What is particularly exciting is the level of out-of-the-box thinking."

—**Denis Hayes**, president of The Bullitt Foundation, board chair of the International Earth Day Network, and *Imagine Tomorrow* 2008 keynote speaker

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energy sources.

PROJECT EXAMPLES

- As much natural gas is used to heat commercial buildings as is used to generate electricity in our state. Develop a set of incentive structures that could be used to get businesses to adopt alternative energy methods for heating or cooling in our state.
- The state tax on gasoline is 54.4 cents per gallon. Examine the effects that raising the state's gas tax would have on driving and transportation in Washington. Explore what share of the gas tax, if any, is spent on measures to conserve gas. If the tax were increased, how would you propose spending the added revenue to achieve the most beneficial result for reducing CO2 emissions?
- Oil refineries in Washington primarily get their crude oil from Alaska, meaning your car probably runs on oil from the North Slope. Examine the implications of drilling in the Arctic National Wildlife Refuge (ANWR) for the State of Washington.

Challenge 4. Multidisciplinary Collaboration

It is clear that viable approaches to a sustainable energy future require contributions from multiple disciplines and perspectives. Develop a project that incorporates expertise from at least two distinct disciplines to address some aspect of the shift toward alternate sources of energy. The disciplines must be distinctly and demonstrably different, and it must be clear that each is making a significant contribution to the overall project .

PROJECT EXAMPLES

- Converting freight trucks to biodiesel and the impact on food prices of doing so (brings together engineering and economics)
- Public reaction to solar panels and re-designing of the panels to make them more aesthetically pleasing (brings together psychology and architecture)
- Historical writing on eco-friendly actions and the impact on current public policy (brings together English and political science)

Imagine Tomorrow, PO Box 641040, Washington State University, Pullman WA 99164-1040, 509-335-1467, Contact Us

U.S. Department of Energy
Energy Efficiency and Renewable Energy

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- Continuing Education
- Teacher Training
- Careers & Jobs

Energy Education Programs

School Buildings & Buses

Printable Version

Careers and Jobs in Energy Efficiency and Renewable Energy

Here you'll find resources about EERE's goals for the energy career market, information about energy-related careers, and job listings in renewable energy and energy efficiency.

- Career Information
- Job Listings

EERE and the Energy Job Market

> "In just a few years, we can watch cars that run on plug-in batteries come off our assembly lines. We can see shuttered factories open their doors to manufacturers that sell wind turbines and solar panels that will power our homes and our businesses. We can watch as millions of new jobs with good pay and good benefits are created for American workers, and we can take pride as the technologies, and discoveries, and industries of the future flourish in the United States of America. We can lead the world, secure our nation, and leave our children a planet that is safer and cleaner and healthier than the one we inherited."
>
> - President Barack Obama,
> August 5, 2008

The United States is accelerating its quest to produce cleaner and more reliable energy and to use it more efficiently. This is creating a dramatic need for skilled workers to bring these changes about and solidify U.S. leadership in energy efficiency and renewable energy. Now, in times of extraordinary economic challenge, we have an opportunity to invest in U.S. workers and green technologies at the same time.

The Office of Energy Efficiency and Renewable Energy (EERE) is beginning to partner with federal and state programs as well as clean energy companies to help build a talented and knowledgeable workforce.

Career Information

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Association of Energy Engineers
A source for information on the dynamic field of energy efficiency, utility deregulation, facility management, plant engineering, and environmental compliance.

Careers in Hydrogen and Fuel Cells
Lists resources that discuss the kinds of education and skills, both technical and non-technical, that will be in demand in this new and exciting field.

Careers in Renewable Energy
A U.S. Department of Energy fact sheet that gives an overview of the career opportunities in the renewable energy field.

DOE Career Opportunities
Features information about career opportunities at the U.S. Department of Energy and its laboratories.

Engineering: Go For It!
Opens up the world of engineering careers to high school students.

Environmental Career Center
Helps people work for the environment through comprehensive environmental and natural resources job listings, career news, inside tips and advice, employer interviews, and career research reports.

The Environmental Careers Organization
Features information on its career services and educational resources to help the next generation of environmental professionals.

Junior Engineering Technical Society
Provides programs and resources for high school students interested in engineering careers.

Occupational Outlook Handbook
A key word search using "energy" will locate information on career opportunities in energy.

The Solar Energy Institute
Offers a one-week summer program in Arizona that gives high school students the opportunity to learn about the solar energy field through lectures, tours, and hands-on research.

Welcome to the World of Engineering!
A guide from the American Society for Engineering Education for high school students interested in engineering and engineering technology careers.

Wisconsin K-12 Energy Education Program: Energy Careers
Features links to information on energy careers, energy education programs, and employers in the energy industry.

Job Listings

Alliance to Save Energy
Lists jobs available at the Alliance to Save Energy and other related organizations.

American Council for an Energy-Efficient Economy (ACEEE)
Lists energy-related employment opportunities at ACEEE and other organizations.

American Wind Energy Association: Wind Energy Career Center
Provides links to employers in the wind energy industry.

Centre for Alternative Technology
Posts vacancies of European companies in the renewable/sustainable development sector.

DOE Jobs Database
Features a searchable database of available jobs at the U.S. Department of Energy, as well as an automated job application system.

Energy Jobs Listings
A list of energy-related employers in the Northwest from the Energy Ideas Clearinghouse.

environmentjob.co.uk
Features listings of renewable energy and energy efficiency jobs and volunteer opportunities in the United Kingdom.

Fuel Cells 2000: Employment Resources
Lists fuel cell companies and helps match qualified job seekers with fuel cell companies.

Green Energy Jobs
A listing of jobs in the renewable energy industry.

Hydro Research Foundation: Job Postings
Posts job listings in the hydropower industry.

National Society of Professional Engineers: Energy Job Board
Features job listings, online resume posting, career tips, mentoring programs, continuing education opportunities, and resources for high school and college students.

National Energy Technology Laboratory Careers and Fellowships
Provides information on position vacancies and research opportunities at the Lab.

National Renewable Energy Laboratory: Employment
Features current job openings at the Lab.

PowerPlantPro
Posts jobs listings for power industry professionals.

Printable Version

Content Last Updated: 02/03/2009

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A section of the DeWind wind turbine.

PHOTO BY DON TIBBIT

Wind Energy Technician

WIND ENERGY TECHNICIANS INSTALL, INSPECT, troubleshoot and repair wind turbines and turbine internal and external components such as programmable controllers, gear boxes, drive components, structural components, electronic equipment and electrical components. They review related manuals, blueprints and schematic diagrams to determine the tasks, tools, equipment and parts needed to maintain a highly automated system.

The Workplace

Wind energy technicians may work in turbine site construction, turbine manufacturing, in the distribution and generation industry, or for a utility company. Sites include wind farms and power plant facilities, and range from small communities to large metropolitan areas.

Educational Requirements

The job of wind energy technician requires the ability to understand and troubleshoot complex equipment, predict and prevent equipment failure, and work as a team member with minimal supervision. Employers are looking for technicians who have the training to apply scientific and theoretical principles along with hands-on skills, and programs at community and technical colleges are growing sources of such training. Schools with programs that train for the wind energy industry include Texas State Technical College, Iowa Lakes Community College and Columbia Gorge Community College in Oregon.

Earnings

Wind energy technicians earn wages from $18.00 to $22.00 per hour, and a recent *Associated Press* story noted that turbine manufacturers and utilities are attempting to lure workers with wages of up to $25.00 per hour. Opportunities also exist for job advancement within the industry.

Job Outlook

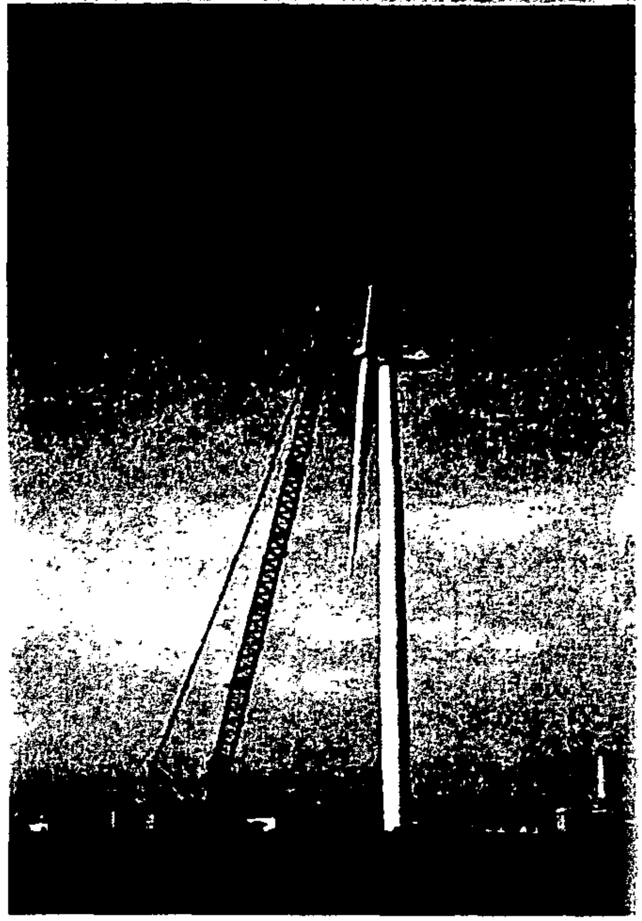
According to the American Wind Energy Association (AWEA), wind energy is one of the fastest growing sources of energy in the U.S. and abroad, with industry growth averaging 22 percent from 2001 to 2006. AWEA also cites estimates from the Pacific Northwest Laboratory that U.S. wind energy potential is more than twice the electricity generated in the U.S. today. This growth and potential should create a greater demand for skilled professionals. T

Explore More

To learn more about the wind energy industry and the growing opportunities for wind energy technicians, here are some sites to visit.

- **American Wind Energy Association** **www.awea.org**
- **Environmental Resources Trust, Inc.** **www.ert.net**
- **National Renewable Energy Laboratory** **www.nrel.gov**
- **Sustainable Energy Coalition** **www.sustainableenergycoalition.org**

School Spotlight



Texas State Technical College, West Texas

At the Sweetwater campus of Texas State Technical College (TSTC), West Texas, students may earn a certificate or an associate degree in the Wind Energy Technology (WET) program, which is designed to provide its graduates with the skills necessary to facilitate an easy transition into many levels of the wind energy industry. The curriculum was developed by the school's subject matter experts in collaboration with an advisory board of wind energy managers.

Doug King, one of the two instructors for the program, says that West Texas is in the center of development for the wind energy industry in the U.S. "We have some of the largest projects in the country," he notes. "The Sweetwater site is 1,000 megawatts, and the Florida Power and Light site is 700 megawatts."

TSTC students study in electronics and engineering labs equipped with new Windows XP networked computers and a variety of digital/analog electronics trainers/testers; electrical power equipment; National Instruments hardware and software instrumentation systems; Allen-Bradley programmable controllers; and an industrial machine vision system to provide the students with a real hands-on environment.

The program was developed to satisfy wind energy industry mandates, and in the first year, the courses include Introduction to Wind Energy, Wind Turbine Materials and Electro-Mechanical Equipment, Wind Power Delivery System, Digital Fundamentals, Industrial Automation, and both DC Circuits and AC Circuits. The students also take classes in topics such as professional development, computer applications, college algebra and composition.

In the second year, the courses include Programmable Logic Controllers, Basic Fluid Power, Wind Business, and Turbine Troubleshooting and Repair. The second year has a humanities/fine arts component and electives in communications and behavioral/social science. There is also a co-op internship in the final semester, when students are required to participate in a paid internship with local companies.

King notes that the school has a brand-new, full-scale wind turbine that was purchased from DeWind, whose parent company is Composite Technology Corp. It is unique in that it uses synchronous power rather than power electronics to connect to the grid, and is the first 60-cycle machine in the United States. GE, Florida Power and Light, and Shermco Industries are among other companies that have contributed materials to the TSTC program.

TSTC notes that although the WET program builds the foundation for entry-level and advanced placement in the wind energy field, many of the classes in the program are offered as support courses and are designed to offer alternative placement options to graduating students who may decide to change career plans and enter a field other than wind energy.

According to King, they currently have 58 students in the program, but some drop out early when they find out that it is not what they want to do. "They spend three days in the field, shadow current technicians, climb turbines and see what the job actually is," he explains. "You have to be self-motivated to climb a 260-foot steel tower."

Students in the TSTC WET program are also provided with the opportunity to network with established industry professionals through the program's advisory committee. The advisory committee's purpose is to identify the knowledge and skills required for entry-level technicians, and it is a mandate of the Texas Higher Education Coordinating Board. The advisory committee for the TSTC WET program includes representatives from Texas Tech University, Florida Power and Light, WTX Wind Energy Consortium and GE Wind Energy.

King notes that students who come to the school are sometimes surprised by the fact that they are learning what he describes as "pretty heady stuff," but those who want to continue their education may go on to get an engineering or business degree. They might even attend Texas Tech University, which has a doctorate program in wind science.

For those who wish to go directly into this growing industry, King sees having graduated from the TSTC program as a huge plus. As he explains, "When they leave the program, they can go to a company and say, 'This is the education I have, and this is the experience I have. I can climb, I am willing to climb, and I can do the job.'"

For more information about the TSTC WET program, visit **www.westtexas.tstc.edu.**

DOE/GO-102001-1130
FS123
January 2001

ENERGY EFFICIENCY AND RENEWABLE ENERGY CLEARINGHOUSE

Careers in Renewable Energy

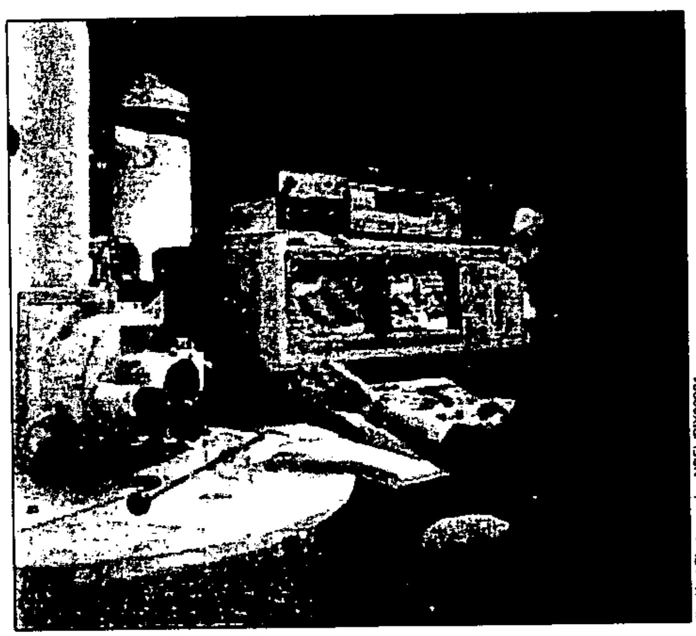
The promise of a clean, never-ending (renewable) power and fuel supply in the United States depends on our ability to harness energy from sources such as the wind, sunlight, organic matter, the Earth's internal heat, and rivers. However, making this promise a reality requires workers dedicated to leading this country toward a sustainable energy future. If you are considering a career in renewable energy, this fact sheet can start you on your way. It will provide you with information on each of the major renewable energy technologies, the types of jobs you might find in each technology, and resources to help continue your research.

Marketplace Trends

The renewable energy industry involves many political, economic, environmental, and technological factors that interact with each other to influence marketplace trends. It is helpful to understand some of these factors because an increase in the market for a certain technology can equal an increase in job opportunities.

There is currently a movement to restructure the power industry. Driven partially by the Energy Policy Act of 1992, the movement intends to provide customers with the opportunity to choose their power provider by decreasing regulation of and introducing competition among utilities. Restructuring is primarily occurring on a state-by-state basis.

Many companies that sell energy produced from renewable sources view the move toward utility restructuring as a great opportunity. In fact, in many states, restructuring has given rise to the glimmerings of a new industry—*green power marketing.* The concept of green power marketing is based on the assumption that consumers will choose and pay more for renewable energy products/services that reflect their environmental values. Green power marketing programs put a price on the environmental value of a product to overcome the cost barrier that has historically limited the generation of renewable energy on a large scale.



Jim Yost Photography, NREL/PIX02021

Leading the United States toward a sustainable energy future requires workers with many different degrees and types of training.

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There are a wide variety of professions available in the renewable energy industry.

Green marketing pilot programs show that the demand for renewable power products in a competitive marketplace may be quite large. Consumer demand for green power —along with the progress of utility restructuring and proposed state and federal mandates/incentives for consumers and utilities to purchase green power—could substantially strengthen the renewable power industry. This, in turn, may further decrease costs of renewable power and increase the number of jobs available in the renewable energy industry.

In addition to domestic markets, international markets for renewable energy systems are growing. International markets are driven by large remote needs for electricity, growing environmental concerns, and in some cases, a limited availability of fossil fuels.

Job Opportunities

There are a wide variety of professions available in the renewable energy industry. This fact can make it challenging to find the right professional niche, but it also provides the opportunity for individuals with many different types and degrees of training to get involved with renewable energy.

Warren Gretz, NREL/PIX02131

A certification test engineer measures the noise from a wind turbine.

Some jobs—such as those in communications, community outreach, sales/marketing, and business support (e.g., corporate planning and finance, accounting, human resources, law, and information technology)—can be found in almost every renewable energy field. Other jobs are specific to individual renewable energy technologies, as shown in the following discussion of the five main renewable energy power sources: wind, solar, bioenergy, geothermal, and hydropower.

Wind Power

People have been using energy from the wind for hundreds of years. Windmills have been used for pumping water or grinding grain. And today, the windmill's modern equivalent—a *wind turbine*—can use the wind's energy to generate electricity. A single, small- or intermediate-sized wind turbine can generate enough electricity to power a house or farm, while a number of large, utility-scale wind turbines can form *wind plants* or *wind farms* that generate enough electricity for tens of thousands of homes.

As the cost of generating electricity from wind power continues to fall, many electricity providers are starting to view wind as an attractive, renewable alternative to fossil fuels (such as coal and natural gas), which are not renewable. The wind industry has grown at a rate of 25 percent per year, making wind power the fastest-growing source of electricity-generation in the world during the 1990s. Although Europe has experienced the majority of growth in the wind industry, the United States installed 905 megawatts (MW) of capacity in 1999—a record year for new wind projects. The nation's total wind capacity reached 2500 MW in December 1999 and is expected to approach 5000 MW by the end of 2001.

Jobs in Wind Power

The wind industry employs both professional and skilled workers in a number of different capacities. New wind projects require people with business, meteorological, and engineering experience to plan and build projects. Meteorologists help engineers identify appropriate sites with suitable wind conditions. Engineers then design the wind plant, working with the utility companies and communities. Construction workers are needed to build the wind plant. And mechanical and electrical technicians, called "windsmiths," are required to operate and maintain the wind turbines.

Warren Gretz, NREL/PIX09150

Scientists are needed to research and develop renewable energy technologies.

Both industry and research laboratories constantly try to improve the design and efficiency of wind turbines. These research and development (R&D) groups generally employ mechanical, electrical, and aeronautical engineers with advanced degrees, as well as experienced technicians. However, others with technical backgrounds may also find jobs.

Solar Power

Anyone who has visited Florida in July knows that the sun can produce heat. And in 1839, French physicist Edmund Bequerel discovered that sunlight could also produce electricity (known as the *photoelectric effect*). Knowledge of the sun's ability to produce both heat and electricity has led to the invention of numerous technologies for capturing the sun's energy. The most common technologies produced and used in the United States today include photovoltaics, concentrating solar power (also known as solar thermal electric) systems, solar hot water systems, and passive solar building design.

Photovoltaics

Photovoltaic (PV) cells, also known as solar cells, produce electricity directly from sunlight. When a PV cell is exposed to the sun, the cell, which is made of semiconductor materials, absorbs a portion of the light that strikes it. If the energy from the absorbed light strikes electrons in the outer shell of an atom, these electrons are freed from their parent atoms. Free electrons can then travel into a circuit in the form of electricity. PV cells can be hooked together to meet many different types of electricity requirements, from pumping water to operating calculators and watches, and lighting homes and communities.

The growing demand for reliable electricity internationally has contributed to the growth of the U.S. PV industry.

PV has traditionally been used in locations where it is expensive or impossible to send electricity through power lines. An increasing number of utility companies are experimenting with using PV to fill their small or more expensive power needs. Some homeowners and commercial building owners are integrating PV systems into their building designs to offset utility power demand and improve power reliability.

The growing demand for reliable electricity internationally has contributed to the growth of the U.S. PV industry—approximately 70 percent of PV systems manufactured in the United States are sold to other countries.

Concentrating Solar Power

Although the mechanics of each method differs, all three concentrating solar power (CSP) technologies—parabolic troughs, power towers, and parabolic dishes—use mirrors to focus incoming sunlight onto a receiver. The receiver collects the sun's energy in the form of heat, which can then be used directly or converted into electricity using a generator.

These technologies are currently in different stages of development. Troughs have a proven track record as a technology that can function effectively for large-scale power needs (such as those of a utility company) and are currently the least expensive way to produce solar electricity. Power towers have also demonstrated an ability to function on a large, utility scale, while parabolic dish systems, still under development, show promise for small-scale projects.

Warren Gretz, NREL/PIX02336

A technician works on a concentrating solar power collector.

CSP technologies have caught the attention of some U.S. utility companies, as well as others interested in tapping into the projected consumer demand for green power supplies, even though the cost of using these technologies to generate electricity is still somewhat high.

Solar hot water systems are increasingly being installed in schools, hospitals, prisons, and other government facilities across the country.

Solar Hot Water

Energy from the sun can also be used to heat water for buildings and swimming pools. Solar water heating systems for buildings typically include a *solar collector,* in which fluid is heated by the sun, and a *storage tank,* which holds the hot fluid after it has been heated by the collector. Systems using fluids other than water require the additional step of passing water through a *heat exchanger* to heat the water. Swimming pool systems are very simple; they generally consist of collectors made of black plastic or rubber through which pool water is pumped to be heated.

Advances in solar hot water technology for buildings have dramatically cut the cost of solar water heaters from about $.20 per kilowatt-hour (kWh) in 1980 to $.08 to $.10 per kWh in 2000. As a result, solar hot water systems are increasingly being installed in schools, hospitals, prisons, and other government-owned facilities across the country. However, the number of solar hot water systems purchased in the United States is still quite small compared to the number purchased in the rest of the world. In 1997, for example, Americans purchased approximately 25,000 systems. Of the systems purchased, the majority were for heating residential swimming pools.


Warren Gretz, NREL/PIX07154

Some architects specialize in passive solar building design.

Passive Solar Building Design

Building orientation, types of construction materials, glass selection, and architectural features all affect the overall energy performance of a building. For a passive solar building, designers consider these features early in the design process along with taking advantage of solar energy to heat and light a building. They also design the building to be cool in summer.

It may cost more to design a passive solar building, but the savings achieved from decreasing the size of the mechanical and electrical systems to heat/cool and light the building, as well as energy cost savings, more than make up the difference.

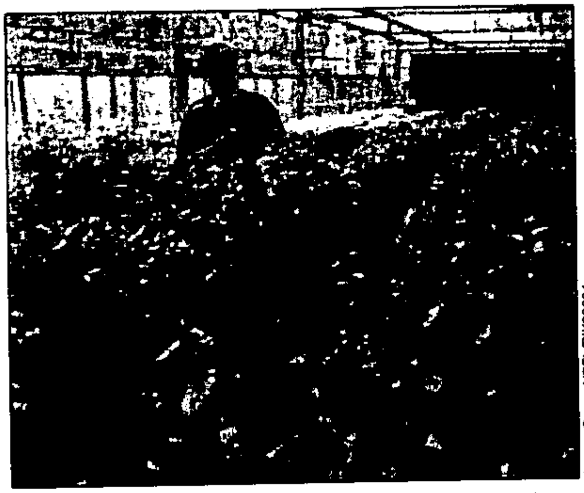
Jobs in Solar Power

Growth of the solar power industry creates high-wage, skilled jobs throughout the country for individuals with many different types of training. R&D groups at national laboratories, universities, and private companies develop and continually improve solar products to lower their costs and improve their reliability. Individuals employed in solar R&D generally have professional degrees in electrical, mechanical, and chemical engineering; materials science, and/or physics. Many of the people involved with technologies that are still under development, such as parabolic dish systems, focus on R&D.

As each technology progresses from the R&D phase toward full-scale commercialization, an increasing number of both professional and skilled workers are needed to sell, manufacture, design, install, and maintain equipment. The PV and solar hot water industries currently employ the majority of these workers, including electricians, engineers, technicians, and technical managers. As utility-scale CSP technologies become commercially viable, the CSP industry will eventually require an increasing number of these workers, as well as engineers and construction workers to design and build power plants. The passive solar industry involves many of these professions as well, but also employs architects and builders.

Bioenergy

The energy stored in *biomass* (organic matter) is called *bioenergy.* People have been burning biomass, such as trees and straw, to cook and warm themselves for thousands of years. Today we not only heat 25 million homes with wood, we also produce 10.2 billion watts of electricity (less



Farmers and foresters grow energy crops for biofuel and biopower production.

than 1 percent of what we use as a nation) from wood waste and waste from other biomass. And we derive up to 0.4 percent of all our transportation fuels (about 1.5 billion gallons) from corn, which is used to produce ethanol.

While we have always used wood and other biomass for heat, the production of electricity and fuels has grown from virtually nothing 20 years ago to what it is today, helping bioenergy become second only to hydropower as the largest source of renewable energy in the world. In addition, we use biomass instead of petroleum to produce between 11 to 15 billion pounds of consumer products, including plastics, glues, furniture, paints, and chemicals.

But as bioenergy technologies and biobased products stand poised to help achieve energy independence for our nation, the conversion of biomass into fuels and products still remains more difficult than the processes used for petroleum or coal.

If R&D and industrial efforts succeed in making bioenergy more profitable, we may see a dramatic increase in the number of bioenergy-related jobs.

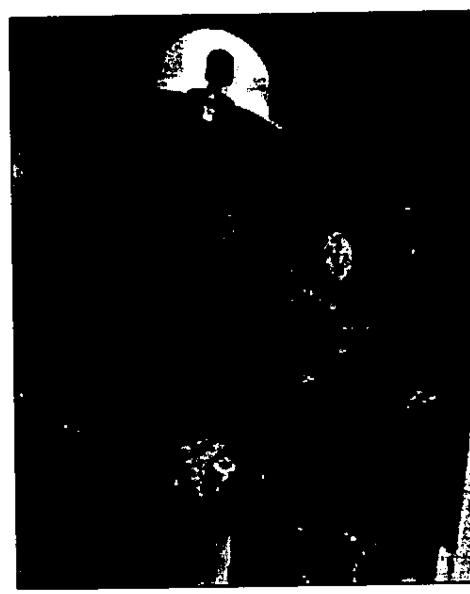
Jobs in Bioenergy

Universities, national laboratories, and industry are working together to find solutions to the difficult problems surrounding the production and use of biomass for energy and products. These R&D efforts require chemists, agricultural specialists, microbiologists, biochemists, and engineers, just to name a few.

Biofuel, biopower, and biobased product plants are most cost-effective when located near their source of biomass. Thus, bioenergy industry development has a special appeal because it creates direct and indirect jobs in rural areas of the country, and may prove to be a profitable complement for many existing agricultural and forestry businesses.

Engineers and construction workers are needed to design and build bioenergy plants, while electrical/electronic and mechanical technicians, engineers (mechanical, electrical, and chemical), mechanics, and equipment operators are needed to run and maintain these plants. Some may even require individuals cross-trained in areas such as engineering and biology, or chemistry and agriculture.

Jobs in bioenergy today cut across a wide spectrum of specialties and skills. And if R&D and industrial efforts succeed in making bioenergy more commercially profitable, we may see a dramatic increase in the number of bioenergy-related jobs. We'll need more farmers and foresters to produce and harvest biomass resources, more truckers to transport the resources to the power and fuel plants, and more operators to run facilities.



A worker operates equipment at a generating station that burns wood to produce electricity.

Geothermal Energy

Heat from the earth, called geothermal energy, is yet another renewable energy resource that people have used over the years. Geothermal energy heats water seeping into underground reservoirs, which can then be tapped for a variety of uses.

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A worker monitors equipment operation at a geothermal power plant.

Low to medium temperature (70° to 225°F) water reservoirs can be used directly to heat buildings, grow and dry crops, melt snow on sidewalks, and for fish farms. This is called the *direct use* of geothermal energy. The energy produced from high temperature reservoirs (225° to 600°F) can spin a turbine to generate electricity.

Current drilling technology limits the development of geothermal resources to relatively shallow, water- or steam-filled reservoirs, most of which are found in the western part of the United States. Researchers are developing new technologies for capturing the heat in the deeper, "dry" rocks, which would support drilling almost anywhere.

Geothermal heat pumps (GHPs) allow us to take advantage of the Earth's constant temperature (around 55°F) just a few yards beneath the surface to heat and cool buildings, and to produce hot water. GHPs transfer heat between the building and the ground by circulating fluid through underground pipes. Currently, the majority of GHPs produced in the United States are purchased domestically, primarily in the Midwest. But as technology improvements reduce the costs of installing GHPs, the demand for this technology will continue to grow throughout the country.

The geothermal industry employs both skilled workers and those with professional degrees.

Jobs in Geothermal Energy

The geothermal industry employs both skilled workers and those with professional degrees.

Developing hot water reservoirs requires geologists, geochemists, geophysicists, hydrologists, reservoir engineers, mud loggers, hydraulic engineers, and drillers to locate, assess, and access the reservoirs. Environmental scientists prepare environmental impact studies, and permit and leasing specialists obtain the land rights.

Geothermal direct-use technologies create jobs for heating engineers, and in the building and agricultural industries. For electricity production, engineers (electrical and mechanical) and construction workers—along with electrical technicians, electricians, electrical machinists, welders, riggers, and mechanics—are needed to design and construct power plants.

Mechanical engineers, geologists, drilling crews, and heating, ventilation, and air conditioning contractors are needed to manufacture and install GHPs. In addition, mechanical and electronic engineers, geologists, chemists, and materials scientists are required for ongoing R&D.

A fish farmer uses a net to catch fish, which are raised in geothermally heated waters.

Hydropower

Hydropower, which uses the energy of flowing water to produce electricity, is the largest and least expensive source of renewable energy produced in the United States today. In fact, hydropower now generates approximately 10 percent of the electricity used in our country (wind, solar, geothermal, and biomass combined produce less than 1 percent). Most hydropower projects use a dam and a reservoir to retain water from a river. When the stored water is released, it passes through and rotates turbines, which spin generators to produce electricity.

The hydropower industry now also employs environmental scientists to assess environmental impacts and address environmental remediation.

Water stored in a reservoir can be accessed quickly for use during times when the demand for electricity is high. Other hydropower plants, called "run of the river" projects, do not require dams. Instead, a portion of a river's water is diverted into a canal or pipe to spin turbines.

Many large-scale dam projects have been criticized for altering wildlife habitats, impeding fish migration, and affecting water quality and flow patterns. As a result of increased environmental regulation, the National Hydropower Association forecasts a decline in hydropower use through 2020. R&D efforts have succeeded in reducing many of these environmental impacts through the use of fish ladders (to aid fish migration), fish screens, new turbine designs, and reservoir aeration. Although funding has been limited, current research focuses on the development of a "next generation turbine," which is expected to further increase fish survival rates and improve environmental conditions.

Jobs in Hydropower

As with many of the other renewable energy technologies, the design, construction, and maintenance of hydropower plants requires electrical and mechanical engineers, technicians, and skilled workers. If the hydropower project also involves managing the reservoir and the surrounding land, the developer will also hire recreation planners, resource managers, and educators. In addition, state and federal licensing laws now require current or prospective hydropower plant developers to assess the environmental effects of their operation. Thus, the hydropower industry now also employs environmental scientists (biologists, hydrologists, ecologists, and wildlife habitat specialists, for example) to assess environmental impacts and address environmental remediation. Environmental scientists, as well as engineers, also participate in R&D efforts through private companies, national laboratories, and universities.

A career in renewable energy is a valuable way for individuals with a wide range of skills and interests to help guide the United States toward a secure, environmentally conscious energy future. For more information on energy careers, specific renewable technologies, and market forecasts, consult the resource list below.

Resources

The following resources may provide more information on renewable energy technologies and careers. This list does not cover all the available resources on renewable energy technologies and careers, nor is the mention of any resource to be considered a recommendation or endorsement.

Energy Efficiency and Renewable Energy Clearinghouse (EREC)
P.O. Box 3048
Merrifield, VA 22116
Phone: 1-800-DOE-EREC (1-800-363-3732)
Fax: (703) 893-0400
E-mail: doe.erec@nciinc.com
Web site: http://www.eren.doe.gov/consumerinfo/

Provides free general and technical information to the public on the many topics and technologies pertaining to energy efficiency and renewable energy.

Organizations

American Bioenergy Association
1001 G. Street, N.W., Suite 900 E.
Washington, D.C. 20001
Web site: http://www.biomass.org/

Promotes the economic and environmental benefits of biomass utilization.

American Solar Energy Society (ASES)
2400 Central Avenue, Suite G-1
Boulder, CO 80301
Phone: (303) 443-3130
Fax: (303) 443-3212
E-mail: ases@ases.org
Web site: http://www.ases.org/

A solar energy information source for everyone, from homeowners to public officials.

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American Wind Energy Association (AWEA)
122 C. Street, N.W., Suite 380
Washington, D.C. 20001
Phone: (202) 383-2504
Fax: (202) 383-2505.
E-mail: windmail@awea.org
Web site: http://www.awea.org/

Advocates the development of wind energy.

Energy Information Administration (EIA)
U.S. Department of Energy
ER-30
1000 Independence Avenue, S.W.
Washington, D.C. 20585
Phone: (202) 586-8800
E-mail: infctr@eia.doe.gov
Web site: http://www.eia.doe.gov

Provides energy data and analyses to assist businesses, government, and the public in understanding energy issues.

Environmental Careers Organization
179 South Street
Boston, MA 02111
Phone: (617) 426-4375
Web site: http://www.eco.org/

Works to enhance the development of environmental careers through internships, career advice, career products, and research and consulting.

Geothermal Education Office
664 Hilary Drive
Tiburon, CA 94920
Phone: 1-800-866-4436
Fax: (415) 435-7737
E-mail: geo@marin.org
Web site: http://geothermal.marin.org/

Along with other educational resources, offers useful information on geothermal careers.

Geothermal Energy Association (GEA)
209 Pennsylvania Avenue, SE
Washington, D.C. 20003
Phone: (202) 454-5261
Fax: (202) 454-5256
E-mail: geo@geo-energy.org
Web site: http://www.geo-energy.org/

A trade association of U.S. companies who support the expanded use of geothermal energy.

Geothermal Resources Council (GRC)
P.O. Box 1350
2001 Second Street, Suite 5
Davis, CA 95617-1350
Phone: (530) 758-2360
Fax: (530) 758-2839
E-mail: grc@geothermal.org
Web site: http://www.geothermal.org/index.html

Serves as a focal point for the continuing professional development of its members.

National Hydropower Association (NHA)
1 Massachusetts Avenue, N.W., Suite 850
Washington, D.C. 20001
Phone: (202) 682-1700
Fax: (202) 682-9478
E-mail: info@hydro.org
Web site: http://www.hydro.org/

Seeks to secure hydropower's place as a reliable and renewable energy resource that serves national environmental and energy policy objectives.

Renewable Fuels Association
1 Massachusetts Avenue, N.W., Suite 820
Washington, D.C. 20001
Phone: (202) 289-3835
Fax: (202) 289-7519
E-mail: info@ethanolrfa.org
Web site: http://www.ethanolrfa.org/

Works to expand the production and consumer use of renewable fuels.

Solar Energy Industries Association (SEIA)
1616 H. Street, N.W., 8th floor
Washington, D.C. 20006-4999
Phone: (202) 628-7745
Fax: (202) 628-7779
Web site: http://www.seia.org/main.htm

Puts out information on solar careers approximately every three years and sometimes posts employment opportunities on its Web site.

Web sites

Energy Career Guide
Energy Education Online
Web site: http://www.energyed.ecw.org/career.html

Provides information on energy careers, schooling, employers, and books.

Energy Efficiency and Renewable Energy Network (EREN)
U.S. Department of Energy
Web site: http://www.eren.doe.gov/

Provides access to hundreds of links and thousands of documents on energy efficiency and renewable energy topics.

Occupational Outlook Handbook
U.S. Department of Labor
Superintendent of Documents
P.O. Box 371954
Pittsburg, PA 15250-7954
(202) 512-1800
Web site: http://stats.bls.gov/ocohome.htm

Provides general information on a wide variety of careers, including those in renewable energy. A hard copy may be ordered by calling the phone number or writing to the address above.

Solstice
Center for Renewable Energy and Sustainable Technology (CREST)
Web site: http://solstice.crest.org/index.

Contains general renewable energy resources, including a directory of energy-related graduate school programs.

University of Alaska - Preparing Alaskans for jobs and careers

Fran Ulmer
February 18, 2009

Green Jobs Potential: National

- The U.S. Conference of Mayors released a report in early October 2008 that finds the U.S. economy currently generates more then 750,000 green jobs, while over the next 30 years, an emphasis on clean energy could cause that number to grow five-fold, to more than 4.2 million jobs.

- Engineering, legal, research, and consulting jobs currently dominate the green jobs in the United States and could grow by 1.4 million by 2038, while renewable electricity production will create 1.23 million jobs, alternative transportation fuels will add 1.5 million jobs, and building retrofits will create another 81,000 jobs.

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University of Alaska Anchorage Catalyst for Green Industry Jobs

- ***University of Alaska Anchorage significant role:***
  - **UAA as Trainer** – supply of skilled graduates
  - **UAA as Innovator** – transfer of knowledge
  - **UAA as Partner** – provides technical expertise to sponsored research; commercialize product; licensing activities;
  - **UAA as Facilitator** – facilitate networking between public/private sector

Role of University: Trainer

- Clearly if America is to rise to the global energy challenge, and capture the economic opportunity it represents, we need to adequately prepare our students.
  - Nationwide, college graduates earn +/- 40% more than non-educated
  - Education directly associated with quality of life, community involvement, civic engagement, reduction in social impacts

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www.uaa.alaska.edu/ctc
Career Pathways to a Bright Future
UAA
½-1½ years
1-2 years
3-3 years
Associate Degree
4-5 years
Bachelor's Degree
Ongoing
Allied Health
Aviation Technology
786-7200
Computer and Electronics Technologies
786-6400
Culinary Arts & Hospitality
786-1487
Transportation and Power
786-6420

Role of University: Innovator

- Research and innovation are the building blocks for new industry development.
  - *52 percent of all research and development activity in the state come from the UA system*
  - *Education and research are symbiotic – the training of the next generation of innovators is best done in a university setting*
  - *Technology transfer is a natural act of all universities – students transferred to industry each year*

Role of University: Partner

- Partnerships between the public and private sectors and universities are critical to success of economic growth strategies.
  - *State of Alaska*
  - *Federal agencies – EDA, USDA*
  - *Alaska Renewable Energy Project*
  - *Alaska Regional Development Organizations*
  - *Denali Commission*
  - *Rasmuson Foundation*
  - *Alaska State Chamber - Chambers of Commerce*

Role of University: Facilitator of Entrepreneurship

- An SBA study observed that, "Innovation without entrepreneurship generally yields minimal local economic impact…innovations are highly portable, whereas entrepreneurship is people/place-based." It's typically the entrepreneur that converts innovation into economic development.*
- Robert Litan, VP of Research & Policy at Kauffman Foundation on current economic crisis:

  "E=R or Entrepreneurship = Recovery"

- Programs of the UA System that support entrepreneurship
  - Center for Economic Development
  - Small Business Development Center
  - Village Income Tax Program

*Source: Council on Competitiveness 2007

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Institutes and Centers - UAA

- **ISER - http://www.iser.uaa.alaska.edu/**

  Conducts non-partisan research that helps Alaskans and others to understand social and economic systems and supports informed public and private decision making.
- **Center for Economic Development - http://ced.uaa.alaska.edu/contact.htm**

  Leverages the resources of the UA campuses to facilitate economic development in communities throughout the state of Alaska.
- **Alaska Small Business Development Center – www.aksbdc.org/**

  Provide small business with free and confidential counseling.
- **Center for Economic Education – http://www.cee.uaa.alaska.edu/default.asp**
- **University of Alaska Corporate Programs - http://www.alaska.edu/uacp/**

  An educational organization established to serve the training and education needs of business and industry.

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Institutes and Centers - UAF

- **Cooperative Extension Service – http://www.uaf.edu/ces/**

  Extends relevant research-based knowledge in an understandable and usable form; and to encourage the application of this knowledge to solve the problems and meet the challenges of Alaska.

- **Agricultural and Forestry Experiment Station**
- **Alaska Center for Climate Assessment and Policy**
- **Alaska Climate Research Center**
- **Center for Global Change and Arctic System Research**
- **Cold Climate Housing Research Center**
- **Geophysical Institute**

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Institutes and Centers - UAS

- **Masters of Business Administration – Distance Delivery**

  This program teaches business skills and links professional peers having a variety of backgrounds and experience with students.

- **Masters of Public Administration**

  This program teaches relevant skills to both public and private non-profit entities. The program provides leadership and management training in policy development, as well as organizational, human resource and budgetary areas.

Conclusion

University of Alaska Anchorage serves a <u>significant role</u> in development of the green economy and green jobs by:

- Providing a well-educated, highly skilled work force
- Engaging in cutting edge, innovative research
- Fostering technology/innovation transfer to industry
- Developing effective public private partnerships
- Launching start-up enterprises through entrepreneurial support programs

APICC Priority Occupations Report 2008 Indicators: Difficult to find qualified workers to hire in this occupation and positions often remain vacant for periods of time.	AK DOL HOT Jobs 2004—2014 Indicators: % growth greater than all occupations as a whole; grow at least 75 jobs over 10 years; rank in top 2 wage quartiles.	AK DOL Focus Jobs 2004—2014 Indicators: Top 25 occupations with most openings, with higher than average wages.	AGIA Training Strategic Plan A Call to Action Indicators: Occupations considered significant in constructing a natural gas pipeline	UAA Programs Connected to Demand
STEM	**STEM**	**STEM**	**STEM**	**STEM**
Chemical Engineers <Bachelor's> $70K +			Chemical Engineers	
Civil Engineers <Bachelor's> $70K +	Civil Engineers		Civil Engineers and Technicians	SOE: Civil Engineering, BSE
Electrical Engineers <Bachelor's> $70K +			Electrical and Electronic Engineers and Technicians	SOE: Electrical Engineering, BSE
Mechanical Engineers <Bachelor's> $70K +	Mechanical Engineers		Mechanical Engineers and technicians	SOE: Mechanical Engineering, BSE
Mining Engineers <Bachelor's> $70K +				
Project Engineers <Bachelor's> $70K +	Engineering Managers		Engineering Managers	SOE: Engineering and Science Management, MS
Project Managers <Bachelor's> $70K +	Construction Manager	Construction Managers	Construction Managers	SOE: Project Management, MS CTC: Construction Management, BS
Operations	General Operations	General & Operations		SOE: Project Management,

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Managers/Supervisors <Bachelor's> $70K +	Manager	Manager		MS CTC: Construction Management, BS
			Materials Engineers	
	Environmental Scientists, including health		Environmental Engineers and technicians, environmental science and protection technicians, environmental scientists Safety: Health/safety engineers Occupational health and safety specialists, hazardous materials removal, health and safety engineers, OHS specialists and technicians, security guards	SOE: Applied Environmental Science and Technology, AEST Environmental Quality Engineering Science, MS KPC; Occupational Safety and Health, AAS
			Drafters, engineering technicians, inspectors, mechanical drafters, surveying and mapping technicians, landscape architects	SOE: Geomatics, BS, AAS, and cert CTC: Architectural Engineering and Technology, AAS and certs
Education	**Education**	**Education**	**Education**	**Education**
		Elementary Teachers, except special ed		COE: Teacher Ed.
		Secondary Teachers, except specials & voc ed		COE: Teacher Ed - MAT
	Postsecondary Teachers			
	Instructional Coordinators			
	Ed, Voc, and School Counselors			COE: Counselor Education
	Special Ed Teachers, Preschool, Kindergarten,			COE: Early Childhood Development, Special Ed,

	Elementary			Elementary Ed.
Business/Finance	**Business/Finance**	**Business/Finance**	**Business/Finance**	**Business/Finance**
	Accountants/Auditors	Accountants/Auditors		CBPP: Accounting, BBA and AAS
Administrative Managers/Supervisors <Bachelor's> $50K +	Administrative Service Managers	Administrative Service Managers		CBPP: MBA, Management, BBA
	Chief Executives	Chief Executives		CBPP: MBA, Management, BBA
	Financial Manager	Financial Managers		CBPP: Finance, BBA
		First Line Supervisors: Office/Retail/Construction/ Mechanics/Installers	First Line Supervisors	CBPP: Management, BBA
	Property, Real Estate, Community Assoc Mgrs			
	Sales Manager			CBPP: Marketing, BBA
	Marketing Mgrs			CBPP: Marketing, BBA
	Loan Officers			CBPP: Finance, BBA
	Securities, Commodities, Financial Services Sales Agents			CBPP: Finance, BBA
			Material Handling: First line Supervisors, Freight handling, order clerks, stock clerks	CBPP: Cert in Logistics
			Administration: Bookkeeping, accounting, budget analysts, cost estimators, placement specialists, admin assistants, file clerks, first line supervisors, HR assistants, payroll clerks, receptionists, training specialists	CBPP: Small Business Admin, AAS, Management, BBA

Information Technology	Information Technology	Information Technology	Information Technology	Information Technology
	Computer System Analyst			CTC; Computer Networking, AAS
	Computer Information Systems Mgrs			CBPP : Management Information Systems, AAS
	Network and Computer Systems Administrators			CTC: Computer Networking and CISCO Academy, AAS and Cert
			Computer systems mgrs, computer programmers, computer support specialists, systems analysts, database administrators	CTC: Computer Information Office Systems and Computer Networking, CISCO Academy, AAS and Certs KPC/Mat Su: Varied computer courses and certs
Transportation	**Transportation**	**Transportation**	**Transportation**	**Transportation**
Heavy Truck Drivers <Driver's License/Endorsements> $50K +		Truck Drivers, Heavy and Tractor-trailer	Truck Drivers, Heavy and Tractor-trailer	
		Automotive Service Technicians	Bus/Truck Mechanics and Diesel Engine Specialists	CTC: Automotive and Diesel Technology, AAS and Certs
		Aircraft Mechanics		
		Airline Pilots, Copilots, and Flight Engineers		CTC: Aviation Technology – Professional Piloting, BA
			Logistics: Drivers, dispatchers, purchasing agents	CBPP: Cert in Logistics
Health	**Health**	**Health**	**Health**	**Health**
		Registered Nurse		CHSW: Nursing, AAS and BS
	Child, Family, School			CHSW: Social Work, MS

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	Social Workers			and BS
	Physicians and Surgeons			CAS: WWAMI
	Social and Community Service Mgrs			CHSW: Social Work, MS and BS
	Medical and Health Services Mgrs			CTC: Medical Assisting, AAS and Cert
	Substance Abuse and Behavioral Disorder Counselors			CHSW: Human Services, AAS, and BS, Social Work, BS
	Pharmacists			CTC: Pharmacy Technology, Cert
	Physical Therapists			
	Mental Health Counselors			
Public Safety	**Public Safety**	**Public Safety**	**Public Safety**	**Public Safety**
		Police Officers/Patrol Officers		
AAS/Apprenticeship/OJT	**AAS/Apprenticeship/OJT**	**AAS/Apprenticeship/OJT**	**AAS/Apprenticeship/OJT**	**AAS/Apprenticeship/OJT**
Electrical Inspectors <AAS or Bachelor's> \$60-\$100K				PWSCC: Industrial Technology – electrical power generation, AAS and cert
Mechanical Inspectors <AAS or Bachelor's> \$60K +				
Non Destructive Examination <AAS or Bachelor's> \$60K +				CTC: Non Destructing Testing, AAS and Cert
H and S Compliance <AAS or Bachelor's> \$60-\$100K				KPC: Occupational Safety and Health, AAS PWSCC: Industrial Technology – safety, AAS and Cert

Machinist & Millwrights <AAS or Apprenticeship or OJT> $70K +			Millwrights	PWSCC: Industrial Technology –Millwright, AAS and vcert KPC: Process Technology, AAS
Maintenance General/Mining Mechanic <AAS or Apprenticeship or OJT> $AAS or Apprenticeship or OJT>		Maintenance & Repair Workers		
Cleaners <HS diploma/GED> $?				
Carpenters <Apprenticeship or training/OJT> $50K +		Carpenters	Carpenters	
Electricians <Apprenticeship or training/OJT> $70K +		Electricians	Electricians	
Pipe Fitters <Qualified Welder with mathematical background> $70K +		Plumbers, Pipe fitters, Steamfitters	Plumbers, Pipe fitters, steamfitters	
		Construction Equipment Operators		
		Sales Reps		
	Surveyors			SOE: Geomatics, BS, AAS and cert
			Crafts: Masons, Laborers, Crushing, Explosives, Fence, Helpers, highway maintenance, insulation, sheet metal, iron, painters	

			Welders	CTC/KPC: Welding, AAS and Cert
			Equipment Operators	
			Operations: Gas Compressor operators, gas plant operators, ,plant and system operators	KPC: Process Technology PWSCC: Industrial Technology, AAS and Certs
			Camps/Catering: Cooks, dishwashers, first line supervisors, food prep, food service, janitors, laundry, housekeeping, general repair	CTC: Culinary Arts, AAS and Cert

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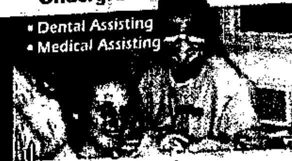
www.uaa.alaska.edu/ctc

Career Pathways to a Bright Future

UAA Community & Technical College

	Recommended High School Preparation*†	½-1 year Occupational Endorsement Certificate	1-2 years Undergraduate Certificate	2-3 years Associate's Degree	4-5 years Bachelor's Degree	Ongoing Professional Development
Allied Health 786.4346	• Algebra • Biology • Chemistry • Computer skills • Health/Health Occupations • Reading and writing	• Clinical Assistant • Coding and Billing • Limited Radiography** • Pharmacy Technology** • Phlebotomist	• Dental Assisting • Medical Assisting	• Dental Assisting • Dental Hygiene • Fire & Emergency Services ◦ Emergency Medical Svcs ◦ Fire Administration ◦ Fire Suppression ◦ Wildland Firefighting • Medical Assisting • Medical Laboratory Technology • Radiologic Technology	• Fire Service Administration (Offered via distance learning through a partnership with Western Oregon University) • Medical Technology	• Dental Assisting • Dental Hygiene • Massage Therapy • Medical Assisting • Medical Laboratory Technology • Pharmacy Technology • Radiologic Technology
Aviation Technology 264.7400	• Algebra II • Computer skills • Geometry • Physics • Reading and writing		• Aviation Maintenance Technology: • Airframe • Powerplant	• Air Traffic Control • Aviation Administration • Aviation Maintenance Technology • Professional Piloting	• Aviation Technology: • Air Traffic Control • Aviation Management • Professional Piloting	
Computer and Electronics Technologies 786.6423	• Algebra • Computer skills • Reading and writing	• Administrative Office Support • Bookkeeping • Cisco Local Academy Networking • Desktop Publishing & Graphics • Medical Office Support • Office Technology • Web Foundations	• Computer Information & Office Systems • Computer & Networking Technology • Telecommunications & Electronics Systems	• Computer Information & Office Systems • Telecommunications, Electronics & Computer Technology	• Technology with or without a Business Emphasis	• Computer and Networking Technology • Computer Information & Office Systems
Construction & Design Technology 786.6423	• Algebra • Computer skills • Construction or industrial technology elective • Reading and writing	• Computer Aided Drafting and Design**	• Architectural Drafting • Civil Drafting • Industrial Welding Technology • Mechanical & Electrical Drafting • Nondestructive Testing Technology • Structural Drafting	• Apprenticeship Technologies • Architectural & Engineering Technology • Construction Management • Welding & Nondestructive Testing Technology	• Construction Management (planned to start Fall 2007) • Technology with or without a Business Emphasis	• Architectural & Engineering Technology • Construction Management • Welding & Nondestructive Testing Technology
[illegible]	[illegible]			• Culinary Arts	• Hospitality & Restaurant Management (senior year taken at NAU or UNLV) • Nutrition Minor	• Culinary Arts • Hospitality & Restaurant Management
Health, Physical Education & Recreation 786.4083	• Algebra II • Biology • Computer skills • Health • Nutrition • Reading and writing • Variety of physical activities	• Coaching Leadership • Fitness Leadership			• Minors (as part of a degree in a different field): ◦ Adventure Leadership ◦ Athletic Training ◦ Coaching ◦ Health & Fitness Leadership ◦ Physical Education • Physical Education ◦ Health & Fitness Leadership Emphasis ◦ Adventure Leadership Emphasis	• Various Health, Physical Education & Recreation Courses
Transportation and Power 786.1485	• Algebra • Computer competency • Industrial technology elective • Reading and writing	• Automotive Brakes, Suspension & Alignment • Automotive Electrical • Automotive Engine Performance • Automotive Power Trains	• Automotive Technology • Heavy Duty Transportation & Equipment	• Automotive Technology • Automotive Technology • Ford ASSET option • General Motors ASEP option • Heavy Duty Transportation & Equipment	• Technology with or without a Business Emphasis	• Automotive and Diesel Technology



†Some of these classes have agreements with UAA that may allow you to earn college credit. Visit the tech prep website for more information: techprep.uaa.alaska.edu.

*This is a general list of recommended classes. Please contact the program adviser to find out more about your specific program.

**These programs are under development. Contact the departments that offer these programs for details.

Applied Environmental Science & Technology
(M- & MS-AEST)

CAREERS WITH OPPORTUNITIES

The Applied Environmental Science & Technology (AEST) program is designed for students seeking careers as environmental professionals in the academic, regulatory, industrial, military, or consulting sectors. The program is interdisciplinary in nature, and encourages students to develop an understanding of environmental principles through advanced studies in biology, chemistry, geology, statistics, and environmental engineering.

Educational Pathway Options

Bachelor of Science (BS)	Graduate Certificate	Master's Degrees
4-5 Years	**1-2 Years**	**1-3 Years**
In most instances, baccalaureate degrees in the physical sciences, life sciences, or engineering will provide a sufficient background to meet course prerequisites.	Port & Coastal Engineering	**Applied Environmental Science & Technology** • **Master (M-AEST)** › **Non-Thesis Option** • **Master of Science (MS-AEST)** › **Thesis Option**

CAREER CONNECTIONS
- Science, Mathematics, Engineering, & Research
- Natural Resources & Environmental Sciences
- Architecture & Construction
- Transportation, Distribution, & Logistics

UAA SCHOOL OF ENGINEERING

APPLICATION PROCESS

ENROLLMENT SERVICES

1. Apply for admission at www.uaa.alaska.edu/admissions.
2. Submit official transcripts reflecting:
   - Completion of a bachelor of science degree from a regionally accredited institution
   - Successful completion of at least one year of calculus and two consecutive semesters in two of the following: chemistry, physics, biology, or geology
   - Minimum 3.0 GPA in natural/physical sciences or engineering
3. Take the GRE and submit official test scores. Waiver available to applicants with significant professional experience.
4. TOEFL scores if applicable.
5. Contact 907.786.1900 for more information.

PROGRAM SPECIFIC

Submit to the School of Engineering:
- Three letters of recommendation from people familiar with the applicant's technical aptitude
- One-page statement of career goals

APPLIED ENVIRONMENTAL SCIENCE & TECHNOLOGY (M-AEST, MS-AEST)

Students are strongly recommended to contact a faculty advisor in the School of Engineering at 907.786.1900 prior to course selection.

BEGINNING THE PROGRAM

Upon admission to the AEST program, students will complete the following actions:

- Meet with an academic advisor prior to the start of classes to plan coursework for the first semester of study. The admissions committee will assign academic advisors, who will be identified in the acceptance letter received by successful applicants.
- Select a Graduate Studies Committee (GSC) consisting of three UAA faculty members – the chair of which is the assigned advisor. The GSC must be selected during the first semester of study.
- Prepare a Graduate Study Plan for approval by the GSC by the end of the first semester.

COMPLETE PROGRAM REQUIREMENTS (24-30 credits)

At least one course, with a grade of 'B' or better, in each of the core competency areas: analysis, biology, chemistry, environmental engineering, and geology. Remaining credits can be selected from the approved course list below. A minimum of 21 credits must be drawn from approved 600-level courses.

- **Analysis**
  - STAT A402 Scientific Sampling (3)
  - STAT A403 Regression Analysis (3)
  - STAT A404 Analysis of Variance (3)
  - STAT A405 Nonparametric Statistics (3)
  - STAT A407 Time Series Analysis (3)
  - STAT A408 Multivariate Analysis (3)
  - STAT A601 Statistical Methods (3)
  - STAT A620 Statistics for ESM (3)
- **Biology**
  - BIOL A478 Biological Oceanography (4)
  - BIOL A650 Advanced Microbial Ecology (3)
  - BIOL A661 Advanced Molecular Biology (3)
  - BIOL A675 Advanced Arctic Tundra Ecosystems (3)
  - BIOL A685 Advanced Topics in Biology (1-5)
- **Chemistry**
  - AEST A601 Aquatic Process Chemistry (3)
  - CHEM A450 Environmental Chemistry (3)
  - CHEM A634 Advanced Instrumental Methods (4)
  - CHEM A641 Advanced Biochemistry I (3)
  - CHEM A642 Advanced Biochemistry II (3)
  - CHEM A698 Individual Research (1-9)
- **Environmental Engineering**
  - AEST A602 Water Quality Management (3)
  - AEST A603 Solid Waste Management (3)
  - AEST A604 Environmental Law, Regulations and Permitting (3)
  - AEST A608 Fundamentals of Air Pollution (3)
  - AEST A613 Remediation (3)
  - AEST A694 Environmental Law (3)
  - CE A411 Introduction to Environmental Engineering (3)
  - CE A600 Fundamentals of Environmental Engineering (3)
  - CE A662 Surface Water Dynamics (3)
  - CE A663 Ground Water Dynamics (3)
  - CE A674 Waves, Tides and Ocean Processes for Engineers (3)
  - CE A677 Coastal Measurements and Analysis (3)
  - CE A683 Arctic Hydrology and Hydraulic Engineering (3)
  - ENVE F651* Risk Assessment (3)
  - ENVE F652* Introduction to Toxicology (3)
  - ESM A450 Economic Analysis and Operations (3)
  - ESM A601 Engineers and Organizations (3)
  - ESM A605 Engineering Economy (3)
  - PM A601 Project Management (3)
- **Geology**
  - GEOL A455 Permafrost (3)
  - GEOL A457 Soil Genesis and Classification (4)
  - GEOL A460 Environmental Geochemistry (3)
  - GEOL A475 Environmental Geophysics (3)
  - GEOL A690 Graduate Topics in Geology (1-4)

**UAF online courses. It is the student's responsibility to check the UAF catalog for current course content and availability.*

COMPLETE THESIS

For MS-AEST degree only.

AEST A699 Thesis (1-6)

SUCCESSFULLY COMPLETE THE COMPREHENSIVE EXAM

MS-AEST is an oral comprehensive examination; M-AEST is a written comprehensive exam.

A total of 30 credits is required. The MS-AEST requires 24 course credits and 6 thesis credits; the M-AEST requires 30 course credits.

Note: Once a student has successfully advanced to candidacy for the MS-AEST degree, that student may not opt to complete their degree under the non-thesis option (M-AEST degree).

12-2007

AEST: 907.786.1951
ACADEMIC ADVISOR: 907.786.1951
WEBSITE: engr.uaa.alaska.edu/programs/environmental/
EMAIL: ayced@uaa.alaska.edu

UAA ENROLLMENT SERVICES: 907.786.1480
ADDRESS: P.O. Box 141629, Anchorage, AK 99514-1629

Project Management (MS)

CAREERS WITH OPPORTUNITIES

The Project Management (PM) program is designed for graduates who currently hold or will hold project management positions in virtually all areas of business and industry: Engineering, Construction, Oil & Gas, Mining, Communications, Healthcare, Information Technology, Utilities, Education, and Transportation in both the private and public sectors, focused primarily, but not exclusively, on technology-driven projects.

Educational Pathway Options

Associate's Degrees	Bachelor's Degrees	Master of Science (MS)
2-3 Years Students with an associate's degree may pursue a baccalaureate degree in an engineering, science, or equivalent area.	**4-5 Years** A baccalaureate degree in an engineering, science, or equivalent area. Degrees include (but not limited to): • Bachelor of Engineering (BSE) • Bachelor of Business Administration (BBA) • Bachelor of Science (BS) • Bachelor of Arts (BA)	**2-3 Years** **Project Management**

CAREER CONNECTIONS • Architecture & Construction • Information Technology • Business, Management, & Administration • Science, Mathematics, Engineering, & Research • Transportation, Distribution, & Logistics • Natural Resources & Environmental Sciences

UAA SCHOOL OF ENGINEERING

APPLICATION PROCESS

ENROLLMENT SERVICES

1. Apply for admission at www.uaa.alaska.edu/admissions
2. Submit official transcripts reflecting:
   - Completion of an undergraduate or MS degree in engineering, science or equivalent areas (as agreed by Department Chair) from a regionally accredited institution
   - Statistics courses
   - All graduate-level credit
3. Contact 907.786.1924 or visit soe.uaa.alaska.edu/espm for additional information.

PROGRAM SPECIFIC

Submit the following:

- Three letters of recommendation from professors, former or current employers, or supervisors who are familiar with the applicant's work experience
- Statement of professional career objectives related to the study of project management

Applicants must have a 'B' average or higher in the last two years of undergraduate work and in a statistics course, and must have at least two years of appropriate project management experience in a science or engineering related field (or as agreed by the Department Chair).

PROGRAM HIGHLIGHTS

- Began in 2003
- Over 100 students located globally
- Accredited in September 2007 by the PMI® Global Accreditation Center (GAC)
- One of the first 13 programs around the globe to receive accreditation
- Designed for working-professional students
- Helps students develop a high-demand skill-set valued in private and public sectors for all fields and industries
- Project Management program built around the Project Management Body of Knowledge (PMBOK®) Guide's nine knowledge areas, five process groups, and professional responsibility
- Courses are taught by a strong team of faculty and instructors who bring extensive academic and professional experience to each course
- Diverse and accomplished student body
- Highly aligned with industry leaders
- Customized and Cohort Programs available
- In-class and global, real-time distance course delivery
- On-line, asynchronous course delivery also available
- Program designed for working-professional students
- Industry sponsored scholarships
- Project Management Institute (PMI®) Registered Education Provider (R.E.P.®)
- Professional Project Management training courses
- Strong ties to UAA graduate-level Engineering Management and Science Management programs
- MSPM graduates hold leadership positions in both public and private sector
- Student-conducted research opportunities
- Program-sponsored volunteer and community service activities

PROJECT MANAGEMENT (MS)

COMPLETE THE CORE CURRICULUM (33 credits)

PM A601*	Project Management Fundamentals (3)
PM A610	Project Scope Management (3)
PM A612	Project Time Management (3)
PM A614	Project Cost Management (3)
PM A616	Project Quality Management (3)
PM A620	Project Human Resources Management (3)
PM A622	Project Communications Management (3)
PM A624	Project Risk Management (3)
PM A626	Project Procurement Management (3)
PM A685*	Project Management Case Study and Research (6)

**Required courses*

A minimum of 33 credits is required for the degree.

- It is strongly recommended that students take PM A601 Project Management Fundamentals in their first semester.
- As a prerequisite for PM A685 registration, students must have a cumulative GPA of 3.0 GPA or better in courses listed on their official graduate studies plans.
- Students who have previously been awarded a master's degree in another program can complete the program with a minimum of 24 credits but must take PM A601 and PM A685.
- The Master of Science Project Management program charges a per-credit program fee equivalent to the per-credit graduate, resident tuition.

2-2008

PROJECT MANAGEMENT: 907.786.1924
DEPARTMENT CHAIR: Dr. Jang Ra, 907.786.1862
WEBSITE: soe.uaa.alaska.edu/espm
EMAIL: ayespm@uaa.alaska.edu

UAA ENROLLMENT SERVICES: 907.786.1480
ADDRESS: P.O. Box 141629, Anchorage, AK 99514-1629

Engineering Management and Science Management (MS)

CAREERS WITH OPPORTUNITIES

The Engineering Management and Science Management (ESM) programs are designed for graduate engineers and scientists who will hold executive or managerial positions in engineering, construction, industrial, or government organizations. The programs address human relations, financial, economic, quantitative, technical, and legal subjects useful in solving problems of management.

Educational Pathway Options

Associate's Degrees	Bachelor of Science (BS)	Master of Science (MS)
2-3 Years	**4-5 Years**	**2-3 Years**
Students with an associate's degree may pursue a baccalaureate degree in an engineering, science, or equivalent area.	A baccalaureate degree in an engineering discipline for the Engineering Management (MS) degree. A baccalaureate degree in any science discipline for the Science Management (MS) degree.	**Engineering Management** **Science Management**

CAREER CONNECTIONS • Architecture & Construction • Information Technology • Business, Management, & Administration • Science, Mathematics, Engineering, & Research • Transportation, Distribution, & Logistics • Natural Resources & Environmental Sciences • Law, Government, & Public Safety

UAA SCHOOL OF ENGINEERING

APPLICATION PROCESS

ENROLLMENT SERVICES

1. Apply for admission at www.uaa.alaska.edu/admissions.
2. Submit official transcripts reflecting:
   - Completion of an undergraduate or MS degree in engineering (for Engineering Management) or any science discipline (for Science Management) from a regionally accredited institution
   - Statistics courses
   - All graduate-level credit
3. Contact 907.786.1924 or visit soe.uaa.alaska.edu/espm for additional information.

PROGRAM SPECIFIC

Applicants must have on-the-job experience in engineering or science.

No more than nine semester credits of appropriate graduate-level coursework completed at other institutions with a grade of 'B' or higher may be transferred. Both substitutions and transfer credits must be approved by the department.

PROGRAM HIGHLIGHTS

- Began in 1961
- Oldest graduate program at UAA
- Over 500 graduates
- Courses are taught by a strong team of faculty and instructors who bring extensive academic and professional experience to each course
- Strong ties to Project Management program
- Diverse and accomplished student body
- ESM graduates hold leadership positions in the public and private sectors
- Student-conducted research opportunities
- Program-sponsored volunteer and community service activities

ENGINEERING MANAGEMENT AND SCIENCE MANAGEMENT (MS)

COMPLETE THE CORE CURRICULUM (21 credits)

ESM A601	Engineers in Organizations (3)
ESM A605	Engineering Economy (3)
ESM A608	Legal Environment for Engineering Management (3)
ESM A610	Cost Estimating (3)
ESM A620	Statistics for ESM or equivalent (3)
ESM A621	Operations Research (3)
PM A601*	Project Management Fundamentals (3)

**PM fee applies*

COMPLETE THE ELECTIVE CURRICULUM (6 credits)

Any ESM, PM, Engineering, Science, Business Administration or other courses approved by ESM advisor.

ESM A606	Advanced Engineering Economy (3)
ESM A613	Management of Technical People (3)
ESM A617	Technology Management (3)
ESM A619	Computer Simulation of Systems (3)
ESM A623	Total Quality Management (3)
ESM A625	Marketing of Business Products and Services (3)
ESM A694G	Management System Dynamics (3)
ESM A694H	Value Engineering (3)
ESM A698	Individual Research (3)

COMPLETE A THESIS OPTION

Both options require a defense.

- **Non-Thesis**
  Complete ESM A684 (ESM Project)
- **Thesis**
  Complete 6 to 9 credits of ESM A699 (ESM Thesis)

A minimum of 30 credits is required for the degree.

- As a prerequisite for ESM A684 or ESM A699, students must have a cumulative 3.0 GPA or better in courses listed on their official graduate studies plan.
- Project Management courses charge an additional per-credit program fee equivalent to the per-credit graduate, resident tuition.

2-2008

ENGINEERING & SCIENCE MANAGEMENT: 907.786.1924
DEPARTMENT CHAIR: Dr. Jang Ra, 907.786.1862
WEBSITE: soer.uaa.alaska.edu/espm
EMAIL: ayespm@uaa.alaska.edu

UAA ENROLLMENT SERVICES: 907.786.1480
ADDRESS: P.O. Box 141629, Anchorage, AK 99514-1629

Engineering (BSE)

Computer Systems • Electrical • Mechanical

CAREERS WITH OPPORTUNITIES

The Engineering BSE program is a design-oriented curriculum incorporating topics which span the foundations of engineering disciplines and prepare students to meet community and industry needs. Students select from one of three specialization tracks: Computer Systems Engineering, Electrical Engineering, or Mechanical Engineering.

Educational Pathway Options

Recommended Preparation	Bachelor of Science in Engineering (BSE)	Graduate Certificate	Master Degrees
High School • Algebra: 2 years • Trigonometry: ½ year • Chemistry: 1 year • Physics: 1 year • English: 3 years	4-5 Years **Engineering** Specialization Tracks: • **Electrical Engineering** • **Mechanical Engineering** • **Computer Systems Engineering** Upon completion of BSE degree, students automatically qualify for a Minor in Mathematics.	1-2 Years Port & Coastal Engineering Upon completion of this certificate, nine credits can be applied toward other graduate degrees at UAA.	1-3 Years • Applied Environmental Science & Technology • Arctic Engineering • Civil Engineering • Engineering Management • Project Management • Science Management

UAA SCHOOL OF ENGINEERING

CAREER CONNECTIONS • Architecture & Construction • Science, Mathematics, Engineering, & Research • Transportation, Distribution, & Logistics • Information Technology • Health Sciences

APPLICATION PROCESS

ENROLLMENT SERVICES

1. Apply for admission at www.uaa.alaska.edu/admissions.
2. Review admission requirements for your student type.
3. Submit required documents to UAA Enrollment Services.
4. Take the SAT, ACT, or Accuplacer test for English and math course placement. Call the UAA Advising & Testing Center at 907.786.4500 for testing information.
5. Make an appointment for academic advising at 907.786.1900 and meet regularly with an advisor.
6. Access the Future Student Checklist online at http://www.uaa.alaska.edu/prospective/checklist.cfm to stay on track.

PROGRAM SPECIFIC

To be approved for the Engineering "major" status, students need to complete the high school preparatory courses with a grade of "C" or better. If one or more of the preparatory courses are not satisfied, the student may be accepted in a "pre-major" status and is advanced to "major" status upon completion of preparatory requirements with departmental approval. Students with either "pre-major" or "major" status are considered enrolled in the BSE program. All students are advised to work with an assigned advisor to develop a course plan.

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ENGINEERING (BSE)

Students are strongly recommended to seek an appointment with a faculty advisor in the School of Engineering, BSE program, at 907.786.1900 prior to course selection.

COMPLETE GENERAL EDUCATION REQUIREMENTS (15 credits)

Fine Arts (3), Humanities (6), Social Sciences (6)
See the BSE website for more information

COMPLETE ADVANCED MATH ELECTIVE (3 credits)

Select one course from the following list:

MATH A310	Numerical Methods (3)
MATH A314	Linear Algebra (3)
MATH A321	Analysis of Several Variables (3)
MATH A324	Advanced Calculus (3)
MATH A371	Stochastic Processes (3)
MATH A407	Mathematical Statistics I (3)
MATH A410	Introduction to Complex Analysis (3)
MATH A422	Partial Differential Equations (3)

COMPLETE ADVANCED ENGINEERING ELECTIVES (12 credits)

See the BSE website for a list of electives.

COMPLETE MAJOR REQUIREMENTS (61 credits)

CHEM A105	General Chemistry I (3)
CHEM A105L	General Chemistry I Lab (1)
COMM A111	Fundamentals of Oral Communications (3)
ENGL A111	Methods of Written Communication (3)
ENGL A212	Technical Writing (3)
ENGR A151	Engineering Practices I (3)
ENGR A161	Engineering Practices II (3)
ENGR A192	Engineering Seminar I (1)
ENGR A251	Engineering Practices III (3)
ENGR A292	Engineering Seminar II (1)
ENGR A392	Engineering Seminar III (1)
ENGR A438	Engineering Systems Design (3)
ES A208	Engineering Mechanics (4)
ES A302	Probability & Statistics (3)
ESM A450	Economic Analysis & Operations (3)
MATH A200	Calculus I (4)
MATH A201	Calculus II (4)
MATH A202	Calculus III (4)
MATH A302	Ordinary Differential Equations (3)
PHYS A211	General Physics I (3)
PHYS A211L	General Physics I Lab (1)
PHYS A212	General Physics II (3)
PHYS A212L	General Physics II Lab (1)

COMPLETE A SPECIALIZATION TRACK

COMPUTER SYSTEMS ENGINEERING (41 credits)

CS A201	Programming Concepts I (3)
CS A202	Programming Concepts II (3)
CS A221	Computer Org. & Assembly Program (3)
CS A320	Operating Systems (3)
CS A330	Algorithms and Data Structures (3)
CSE A445	Computer Design & Interfacing (4)
EE A203	Fundamentals of Electrical Engr I (4)
EE A204	Fundamentals of Electrical Engr II (4)
EE A241	Computer Hardware Concepts (4)
EE A314	Electromagnetics (3)
EE A314L	Electromagnetics Laboratory I (1)
EE A351	Signals & Systems (3)
EE A465	Telecommunications (3)
	Total Credits for Degree = 132

ELECTRICAL ENGINEERING (41 credits)

CS A201	Programming Concepts I (3)
CS A202	Programming Concepts II (3)
CS A221	Computer Org. & Assembly Program (3)
EE A203	Fundamentals of Electrical Engr I (4)
EE A204	Fundamentals of Electrical Engr II (4)
EE A241	Computer Hardware Concepts (4)
EE A314	Electromagnetics (3)
EE A314L	Electromagnetics Lab I (1)
EE A324	Electromagnetics II (3)
EE A324L	Electromagnetics Lab II (1)
EE A351	Signals & Systems (3)
EE A353	Circuit Theory (3)
EE A441	Integrated Circuit Design (3)
EE A465	Telecommunications (3)
	Total Credits for Degree = 132

MECHANICAL ENGINEERING (39 credits)

CHEM A106	General Chemistry II (3)
CHEM A106L	General Chemistry II Lab (1)
ES A309	Elements of Electrical Engineering (3)
ES A331	Mechanics of Materials (3)
ES A341	Fluid Mechanics (4)
ES A346	Basic Thermodynamics (3)
ME A302	Mechanical Design I (4)
ME A308	Instrumentation and Measurements (3)
ME A313	Mechanical Engineering Thermodynamics (3)
ME A334	Elements of Material Science (3)
ME A403	Mechanical Design II (3)
ME A414	Thermal System Design (3)
ME A441	Heat & Mass Transfer (3)
	Total Credits for Degree = 130

The programs within the University Honors College may satisfy some of the degree requirements while providing challenging opportunities to excel. To find out more, go to www.uaa.alaska.edu/honors or call 907.786.1086.

12-2007

SCHOOL OF ENGINEERING:
www.engr.uaa.alaska.edu/index.cfm
BSE PROGRAM ADVISOR: 907.786.1900
BSE WEBSITE: www.engr.uaa.alaska.edu/programs/bse
FAX: 907.786.1079

UAA ENROLLMENT SERVICES: 907.786.1480
ADDRESS: P.O. Box 141629, Anchorage, AK 99514-1629

Economics (BBA, BA)

TURNING OPPORTUNITY INTO SUCCESS

The Economics Department provides students with a systematic way of understanding activity in the world around them. Economics is often called the "science of choice," as it studies how individuals, organizations, and governments make choices about the use of resources. A degree in economics gives students career opportunities in many fields and provides excellent preparation for advanced study in a variety of disciplines.

Educational Pathway Options

Recommended Preparation	Bachelor's Degrees	Graduate Certificates
High School	4-5 Years	1-3 Years
• Reading and Writing Skills • Basic Computer Skills • Mathematics • Statistics • Economics • History	**Economics** • **Bachelor of Business Administration (BBA)** • **Bachelor of Arts (BA)**	• General Management (MBA) • Public Administration (MPA) • Global Supply Chain Management (MS) • Supply Chain Management (GRAD CERT)

CAREER CONNECTIONS • Education & Training • Law, Government, & Public Safety • Business, Management, & Administration • Natural Resources & Environmental Sciences • Science, Mathematics, Engineering, & Research

UAA COLLEGE OF BUSINESS AND PUBLIC POLICY

APPLICATION PROCESS

ENROLLMENT SERVICES

1. Apply for admission at www.uaa.alaska.edu/admissions.
2. Review admission requirements for your student type.
3. Submit required documents to UAA Enrollment Services.
4. Take the SAT, ACT, or Accuplacer test for English and math course placement. Call the UAA Advising & Testing Center at 907.786.4500 for testing information.
5. Make an appointment for academic advising at 907.786.4100 and meet regularly with an advisor.
6. Access the Future Student Checklist online at http://www.uaa.alaska.edu/prospective/checklist.cfm to stay on track.

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ECONOMICS (BA)

YEAR 1	Credits	Semester	Grade
Written Communication GER	3		
COMM 111, 235, 237, or 241	3		
Humanities GER	3		
Natural Science GER	3		
MATH 172 or 107	3/4		
Written Communication GER	3		
Humanities GER	3		
Natural Science GER with Lab	4		
CIS 110 (Computer Concepts in Business)	3		
Elective	3		

YEAR 2	Credits	Semester	Grade
ECON 201 (Macroeconomics)	3		
MATH 272 or 200	3/4		
Social Science GER	3		
Elective	3		
Elective	3		
ECON 202 (Microeconomics)	3		
BA 273 (Intro to Statistics for Business)	3		
Fine Arts GER	3		
Social Science GER	3		
Elective	3		

YEAR 3	Credits	Semester	Grade
ECON 321 (Intermediate Microeconomics)	3		
ECON 350 (Money and Banking)	3		
Upper-Division Elective	3		
Upper-Division Elective	3		
Elective	3		
ECON 324 (Intermediate Macroeconomics)	3		
Upper-Division ECON Elective	3		
Upper-Division Elective	3		
Upper-Division Elective	3		
Elective	3		

YEAR 4	Credits	Semester	Grade
ECON 412 (Econometrics)	3	/	/
Upper-Division ECON Electives	6	/	/
Capstone GER	3		
Upper-Division Elective	3		
Upper Division ECON Elective	3		
Upper-Division Electives	6	/	/
Elective	3-5		

ECONOMICS (BBA)

YEAR 1	Credits	Semester	Grade
Written Communication GER	3		
COMM 111, 235, 237, or 241	3		
Humanities GER	3		
Natural Science GER	3		
Social Science GER	3		
CIS 110 (Computer Concepts in Business)	3		
ENGL 212 (Technical Writing)	3		
MATH 172 or 107	3/4		
Humanities GER	3		
Natural Science GER with Lab	4		

YEAR 2	Credits	Semester	Grade
ACCT 201 (Financial Accounting)	3		
BA 241 (Business Law I)	3		
ECON 201 (Macroeconomics)	3		
MATH 272 or 200	3/4		
Social Science GER	3		
ACCT 202 (Managerial Accounting)	3		
BA 273 (Intro to Statistics for Business)	3		
ECON 202 (Microeconomics)	3		
Fine Arts GER	3		
Elective	3		

YEAR 3	Credits	Semester	Grade
BA 300 (Organizational Behavior)	3		
BA 325 (Corporate Finance)	3		
CIS 305 (Managerial Presentations)	3		
ECON 321 (Intermediate Microeconomics)	3		
ECON 350 (Money and Banking)	3		
BA 377 (Operations Management)	3		
BA 343 (Principles of Marketing)	3		
CIS 376 (Management Information Systems)	3		
ECON 324 (Intermediate Macroeconomics)	3		
Elective	3		

YEAR 4	Credits	Semester	Grade
ECON 429 (Business Forecasting)	3		
Upper-Division ECON Electives	6	/	/
Capstone GER	3		
BA 488 (Environment of Business)	3		
Upper-Division ECON Electives	6	/	/
Elective	3		
Electives	3-5		

A total of 120 credits is required for each degree, of which 48 credits must be upper-division.
This is a suggested course sequence and students should refer to the UAA Course Catalog for current information.

SCHOLARSHIP OPPORTUNITIES

UAA College of Business & Public Policy Scholarship
UAA Jan & Glenn Fredericks Scholarship *(Junior or Senior standing)*
UAA Bradford Tuck Scholarship *(Junior and Senior Economic Majors)*
UAA Diane Olsen Memorial Scholarship *(Junior and Senior Economic Majors)*

www.uaa.alaska.edu/scholarships

COLLEGE OF BUSINESS & PUBLIC POLICY

Earned Excellence
The Best Business Schools in the World

The College of Business & Public Policy is accredited by the Association to Advance Collegiate Schools of Business, International.

The programs within the University Honors College may satisfy some of the degree requirements while providing challenging opportunities to excel. To find out more, go to www.uaa.alaska.edu/honors or call 907.786.1086.

11-2007

COLLEGE OF BUSINESS & PUBLIC POLICY:
www.cbpp.uaa.alaska.edu
STUDENT INFORMATION: 907.786.4100
FAX: 907.786.4119

UAA ENROLLMENT SERVICES: 907.786.1480
ADDRESS: P.O. Box 141629, Anchorage, AK 99514-1629

Finance (BBA)

TURNING OPPORTUNITY INTO SUCCESS

The Bachelor of Business Administration in Finance is a professional degree designed to prepare students to pursue meaningful and rewarding careers in financial management of corporations or non-profit organizations; investment banking and money management; retirement planning and management of pension funds; banking and insurance industry; real estate development, sales and property management.

Educational Pathway Options

Recommended Preparation	Bachelor of Business Administration (BBA)	Graduate Degrees
High School	**4-5 Years**	**1-3 Years**
• Reading and Writing Skills • Basic Computer Skills • Mathematics	**Finance** Concentration Areas: • **Real Estate and Property Management** • **Investment**	• General Management (MBA) • Public Administration (MPA) • Global Supply Chain Management (MS) • Supply Chain Management (GRAD CERT)

UAA COLLEGE OF BUSINESS AND PUBLIC POLICY

CAREER CONNECTIONS • Human Services • Business, Management, & Administration • Law, Government, & Public Safety

APPLICATION PROCESS

ENROLLMENT SERVICES

1. Apply for admission at www.uaa.alaska.edu/admissions.
2. Review admission requirements for your student type.
3. Submit required documents to UAA Enrollment Services.
4. Take the SAT, ACT, or Accuplacer test for English and math course placement. Call the UAA Advising & Testing Center at 907.786.4500 for testing information.
5. Make an appointment for academic advising at 907.786.4100 and meet regularly with an advisor.
6. Access the Future Student Checklist online at http://www.uaa.alaska.edu/prospective/checklist.cfm to stay on track.

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REAL ESTATE & PROPERTY MGMT (BBA)

	Credits	Semester	Grade
YEAR 1			
Written Communication GER	3		
COMM 111, 235, 237, or 241	3		
Humanities GER	3		
Natural Science GER	3		
Social Science GER	3		
CIS 110 (Computer Concepts of Business)	3		
ENGL 212 (Technical Writing)	3		
MATH 172 or 107	3/4		
BA 131 (Personal Finance)	3		
Natural Science GER with Lab	4		
YEAR 2			
ACCT 201 (Financial Accounting)	3		
BA 241 (Business Law I)	3		
ECON 201 (Macroeconomics)	3		
MATH 272 or 200	3/4		
Humanities GER	3		
ACCT 202 (Managerial Accounting)	3		
BA 273 (Intro to Statistics for Business)	3		
ECON 202 (Microeconomics)	3		
BA 242 (Business Law II)	3		
Fine Arts GER	3		
YEAR 3			
BA 300 (Organizational Behavior)	3		
BA 325 (Corporate Finance)	3		
BA 343 (Principles of Marketing)	3		
CIS 305 (Managerial Presentations)	3		
Elective	3		
BA 377 (Operations Management)	3		
CIS 376 (Management Information Systems)	3		
BA 306 (Real Estate Principles)	3		
Upper-Division Real Estate Elective	3		
Elective	3		
YEAR 4			
BA 320 (Real Estate Finance)	3		
BA 488 (Environment of Business)	3		
Upper-Division Real Estate Electives	6	/	
Upper-Division Business or Real Estate Elective	3		
Upper-Division Business Elective	3		
Upper-Division Business or Real Estate Electives	6	/	
Elective	3-5		

INVESTMENT (BBA)

	Credits	Semester	Grade
YEAR 1			
Written Communication GER	3		
COMM 111, 235, 237, or 241	3		
Humanities GER	3		
Natural Science GER	3		
Social Science GER	3		
CIS 110 (Computer Concepts in Business)	3		
English 212 (Technical Writing)	3		
MATH 172 or 107	3/4		
Humanities GER	3		
Natural Science with Lab	4		
YEAR 2			
ACCT 201 (Financial Accounting)	3		
BA 241 (Business Law I)	3		
ECON 201 (Macroeconomics)	3		
MATH 272 or 200	3/4		
Elective	3		
ACCT 202 (Managerial Accounting)	3		
BA 273 (Intro to Statistics for Business)	3		
ECON 202 (Microeconomics)	3		
BA 242 (Business Law II)	3		
Fine Arts GER	3		
YEAR 3			
BA 300 (Organizational Behavior)	3		
BA 325 (Corporate Finance)	3		
BA 343 (Principles of Marketing)	3		
CIS 305 (Managerial Presentations)	3		
Elective	3		
BA 377 (Operations Management)	3		
CIS 376 (Management Information Systems)	3		
ECON 429 or BA 375	3		
BA 385 (Advanced Corporate Finance)	3		
Elective	3		
YEAR 4			
BA 380 (Investment Management)	3		
BA 488 (Environment of Business)	3		
Upper-Division Finance Electives	6	/	
Upper-Division Business or Finance Elective	3		
Upper-Division Finance Electives	6	/	
Upper-Division Business or Finance Electives	6	/	
Elective	3-5		

A total of 120 credits is required for each degree, of which 48 credits must be upper-division.
This is a suggested course sequence and students should refer to the UAA Course Catalog for current information.

SCHOLARSHIP OPPORTUNITIES

UAA College of Business & Public Policy Scholarship
UAA Jan & Glenn Fredericks Scholarship *(Junior or Senior standing)*
UAA Michael D. Ford Scholarship *(Business Majors)*
UAA Eduardo Gustavo Prieto Scholarship *(Logistics and Business Majors)*
http://www.uaa.alaska.edu/financialaid/scholarship.cfm

COLLEGE OF BUSINESS & PUBLIC POLICY

Earned Excellence
The Best Business Schools in the World

The College of Business & Public Policy is accredited by the Association to Advance Collegiate Schools of Business, International.

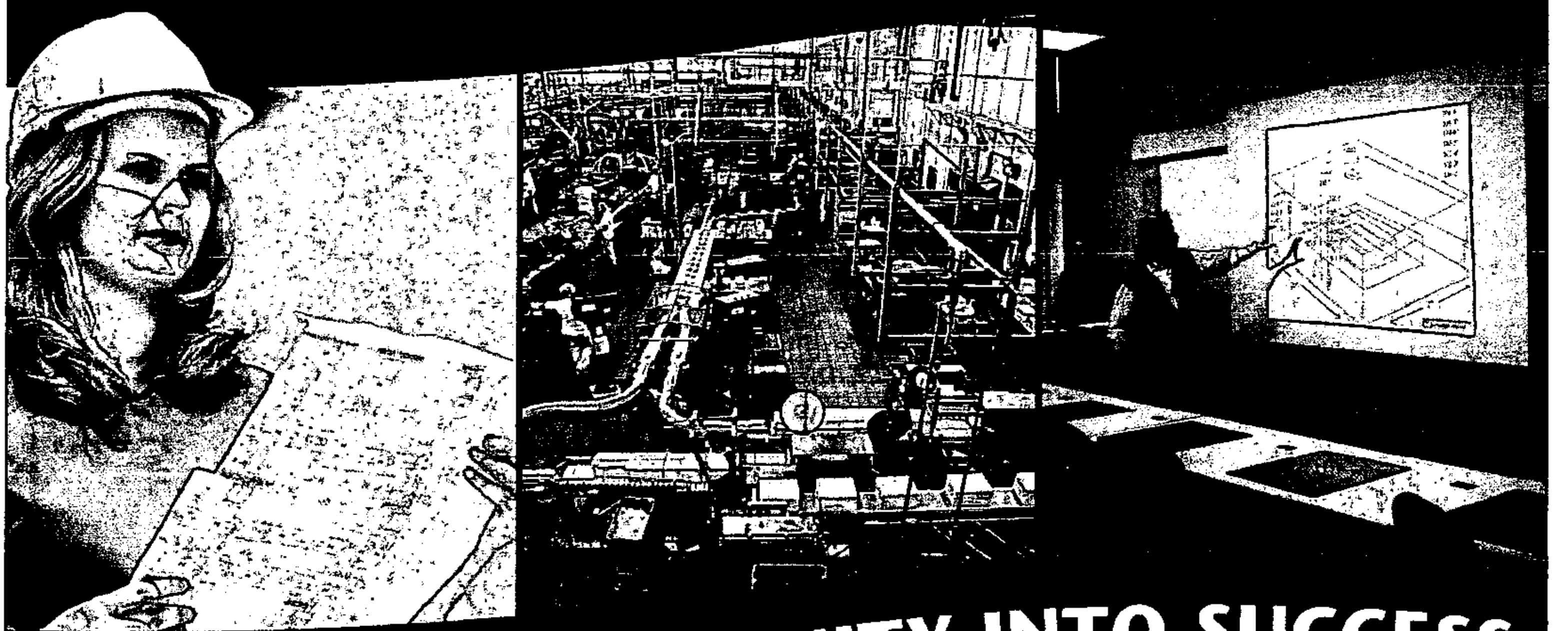
The programs within the University Honors College may satisfy some of the degree requirements while providing challenging opportunities to excel. To find out more, go to www.uaa.alaska.edu/honors or call 907.786.1086.

10-2007

COLLEGE OF BUSINESS & PUBLIC POLICY:
www.cbpp.uaa.alaska.edu
STUDENT INFORMATION: 907.786.4100
FAX: 907.786.4119

UAA ENROLLMENT SERVICES: 907.786.1480
ADDRESS: P.O. Box 141629, Anchorage, AK 99514-1629

Global Logistics Management (BBA)



TURNING OPPORTUNITY INTO SUCCESS

Logistics refers to the movement of material into and within a business firm and the distribution of final products to customers. The Bachelor of Business Administration in Global Logistics Management is a professional degree designed to prepare students to pursue meaningful and rewarding careers in management. Prospective employers include business firms, nonprofit organizations, and government agencies.

Educational Pathway Options

Recommended Preparation	Associate of Applied Science (AAS)	Bachelor of Business Administration (BBA)	Graduate Degrees
High School • Reading and Writing Skills • Basic Computer Skills • Mathematics: 3 to 4 years of college preparatory math	2-3 Years Logistics Operations **Certificate** 1-2 Years Logistics	4-5 Years **Global Logistics Management**	1-4 Years • Global Supply Chain Management (MS) • Supply Chain Management (GRAD CERT) • General Management (MBA) • Public Administration (MPA)

CAREER CONNECTIONS

- Transportation, Distribution, & Logistics
- Business, Management, & Administration
- Architecture & Construction

UAA COLLEGE OF BUSINESS AND PUBLIC POLICY

APPLICATION PROCESS

ENROLLMENT SERVICES

1. Apply for admission at www.uaa.alaska.edu/admissions.
2. Review admission requirements for your student type.
3. Submit required documents to UAA Enrollment Services.
4. Take the SAT, ACT, or Accuplacer test for English and math course placement. Call the UAA Advising & Testing Center at 907.786.4500 for testing information.
5. Make an appointment for academic advising at 907.786.4100 and meet regularly with an advisor.
6. Access the Future Student Checklist online at http://www.uaa.alaska.edu/prospective/checklist.cfm to stay on track.

The University of Alaska Anchorage has been continuously accredited by the Northwest Commission on Colleges and Universities since 1974.
This brochure is for information purposes only and does not constitute a contract. UAA is an EO/AA employer and educational institution.

GLOBAL LOGISTICS MANAGEMENT (BBA)

YEAR 1	Credits	Semester	Grade
Written Communication GER	3		
COMM 111, 235, 237, or 241	3		
Humanities GER	3		
Natural Science GER	3		
Elective[1]	3		
CIS 110 (Computer Concepts in Business)	3		
ENGL 212 (Technical Writing)	3		
MATH 172 or 107	3/4		
Humanities GER	3		
Natural Science GER with Lab	4		

YEAR 2	Credits	Semester	Grade
ACCT 201 (Financial Accounting)	3		
BA 241 (Business Law I)	3		
ECON 201 (Macroeconomics)[2]	3		
MATH 272 or 200	3/4		
Social Science GER	3		
ACCT 202 (Managerial Accounting)	3		
BA 273 (Intro to Statistics for Business)	3		
ECON 202 (Microeconomics)[2]	3		
Fine Arts GER	3		
Elective[1]	3		

YEAR 3	Credits	Semester	Grade
BA 300 (Organizational Behavior)	3		
BA 325 (Corporate Finance)	3		
BA 377 (Operations Management)	3		
LOG 378 (Global Logistics Supply Chain)	3		
CIS 305 (Managerial Presentations)	3		
LOG 379 (Transportation Management)	3		
CIS 376 (Management Information Systems)	3		
BA 343 (Principles of Marketing)	3		
Elective[1]	3		
Elective[1]	3		

YEAR 4	Credits	Semester	Grade
LOG 415 (Purchasing Management)	3		
LOG 495 (Internship)[3]	3		
Upper Division Logistics Elective	3		
Upper-Division Logistics Elective	3		
Elective[1]	3		
BA 488 (Environment of Business)	3		
LOG 416 (International Logistics)	3		
LOG 417 (Material Management)	3		
Upper-Division Logistics Elective	3		
Elective[1]	0-2		

A total of 120 credits is required for this degree, 48 of which must be upper-division.
This is a suggested course sequence and students should refer to the UAA Course Catalog for current information.

[1] Upper or lower-division courses.

[2] ECON 201 or ECON 202 (not both) may be used to satisfy 3 credits of a Social Science GER.

[3] The internship is intended to be in logistics. This requirement may be waived if the advisor determines that the student already has significant logistics work experience. Students are urged to discuss the internship requirement with their advisor early in the semester, before registering for the course.

SCHOLARSHIP OPPORTUNITIES

UAA College of Business & Public Policy Scholarship
UAA Michael D. Ford Scholarship *(Business Majors)*
UAA Eduardo Gustavo Prieto Scholarship *(Logistics or Business Majors)*
UAA National Defense Transportation Scholarship *(Logistics Majors)*
UAA Greg Wolf Scholarship *(Logistics Majors)*
www.uaa.alaska.edu/scholarships

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11-2007

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ADDRESS: P.O. Box 141629, Anchorage, AK 99514-1629

Career Clusters titles are being used with permission of the States' Career Clusters Initiative, 2006, www.careerclusters.org.

The UAS MBA

The Master of Business Administration (MBA) is a graduate professional degree designed to provide training in a broad set of managerial skills. Usually, it is for managers who are taking on responsibilities beyond the narrow focus of a specific business function. For example, it is not about learning lots of accounting detail, or marketing detail, etc. MBA programs do look at state-of-the-art thinking in the various business functions in some depth, but not to make people specialists in a particular business function.

Rather, most MBA programs aim to give participants an understanding of how accounting, marketing, and the whole set of business functions must fit together into a coherent whole for the organization to function well. Higher level managers need to know something of all the functions to manage the organization well.

Typically, MBA programs offer a mix of theory and practice. In other words, participants are brought up-to-date on current management concepts, and the programs make sure that participants know how to translate those concepts into the real world to perform better in their own jobs and their own organizations.

UAS MBA in Service Management: The UAS School of Business, Public Administration, & Information Systems is small, but has high quality faculty. Frequently the best small organizations in markets full of competitors aim to supply high quality, specialized products / services, and stay away from direct competition in mass produced, generic offerings. The UAS MBA focuses on Service Management to give participants a thorough understanding of services and how to manage them.

"The MBA Program was challenging and rewarding. It enhanced my management skills which I have since applied in Alaska State government."

--Guy Bell
Assistant Commissioner
Dept. of Labor & Workforce Development
UAS MBA Graduate

The focus of the UAS MBA program is tailored to Alaska 's economic trends. Projections by the Alaska Department of Labor & Workforce Development indicate that the vast majority of jobs created over the next decade will be in various services areas: (http://labor.state.ak.us/trends/sep04.pdf). The need for skilled managers in rapidly growing services industries is becoming critical to keep Alaska 's economy competitive. A few examples of service industries in Alaska which need well-trained managers include:

- health care services
- retailing & wholesaling
- tourism & hospitality
- financial services

- logistics services
- oil field and mining support services
- professional services (doctors, lawyers, architects, accountants, etc.)

Managers from almost any service industry will find the UAS MBA in Service Management filled with current thinking about how to manage the broad range of activities necessary to provide high quality service to customers / users. This knowledge is integrated into a strongly applications oriented approach. Our goal is that every participant will be able to take something from each course directly into their jobs, to immediately begin contributing toward better performance for their organizations.

Master's Degree (M.B.A.)
Business Administration in Service Management

The master program in business administration is practice-oriented, relevant to Alaskan industries, and leads to a general master of business administration degree. The program features an initial three-day residential seminar in Juneau to set the agenda, ten 3-credit, gradate-level (600) business courses offered sequentially in a seven-week web-delivered format, and two additional elective courses selected in consultation with an advisor. It is delivered to an annual cohort consisting of 25 students maximum. The program is two years in length. Student commitment to participate for the full two years is a condition of admission.

For updated information on application deadlines, continue to consult the MBA Website.

PREREQUISITES

Students entering the MBA program are expected to have introductory level knowledge of management, marketing, accounting, statistics, and micro- and macroeconomics. Students whose transcripts are deficient in any of these subjects must prove competency citing relevant business experience.

APPLICATION REQUIREMENTS

1. Online application available at UAOnline including $60 application fee
2. Official academic transcript sent directly to UAS from the college or university which awarded the baccalaureate degree
3. Professional resume or vita
4. A 1,200 word statement of professional objectives describing past vocational experiences, outlining profession goals and stating how the UAS MBA program might help you achieve your professional objectives. Please not how your background and experience will contribute to the quality of the discussion among program participants. In talking about your academic background, please include where and when you completed the prerequisite courses required in the UAS MBA classes
5. Three letters of reference must be sent directly from the referee. These three references should preferably include someone familiar with your prior academic work and someone familiar with your managerial experience
6. Items 1-5 are required for a complete application file. If you wish, you may also submit any other documentation which you feel is relevant and important for our admission decision

DEGREE REQUIREMENTS (2008-2009 catalog)

Candidates for the Master of Business Administration degree must satisfy all University graduate degree requirements in the UAS catalog as well as the specific program requirements in this section. Students must earn a B in all core courses (3.00)

Minimum Credit Hours			36
Major Requirements			**36**
BA	S610	Management Information Systems	3

1283

Senate Special Committee on World Trade, Technology & Innovation

Training for Emerging Alternative Energy Technology Jobs

Click Bishop, Commissioner DOLWD

Fred Esposito, Director AVTEC

February 18, 2009

www.avtec.edu

AVTEC

12.84

AVTEC

Alaska Vocational Technical Center

Great Careers for Alaska's Future

1285

Mission Statement

To train a diverse and effective workforce that supports the economic growth and stability of our state.

www.avtec.edu

AVTEC

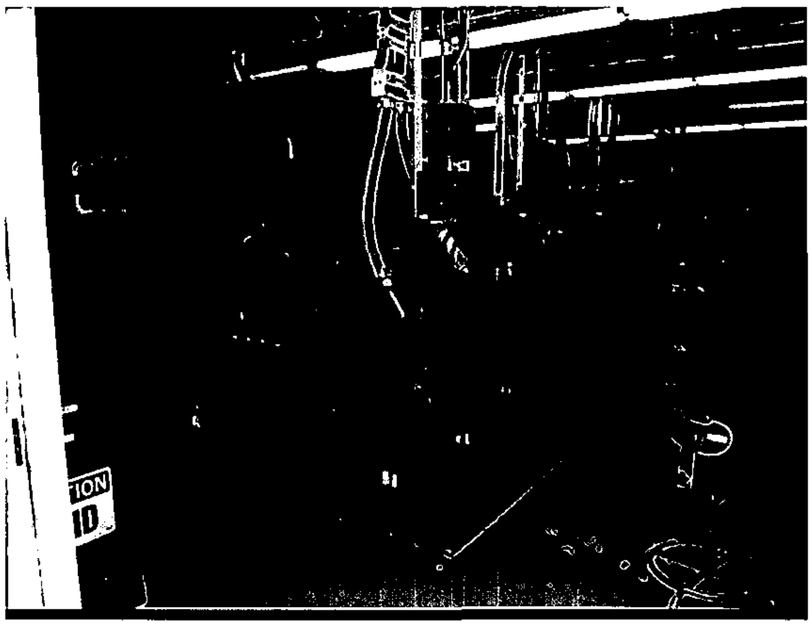
Who We Are

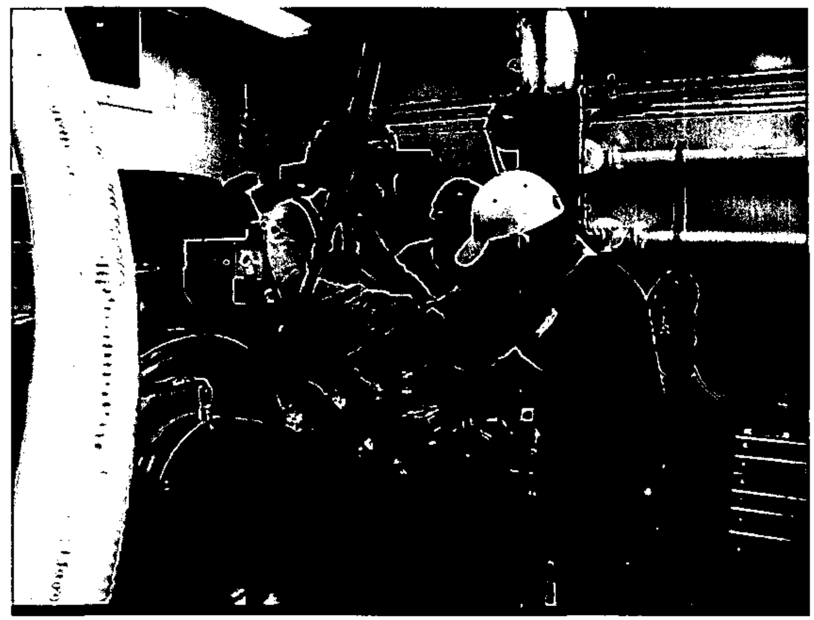
- A component of the Alaska Department of Labor and Workforce Development
- Providing occupational training since 1969. Nearly Forty Years! In Seward, Anchorage, and through Distance Delivery
- Enroll approximately 1,200 students per year in job preparatory and job upgrade training programs

12.87

Diesel Power Plant Operator

- 8 week training program
- Partnership with Alaska Energy Authority

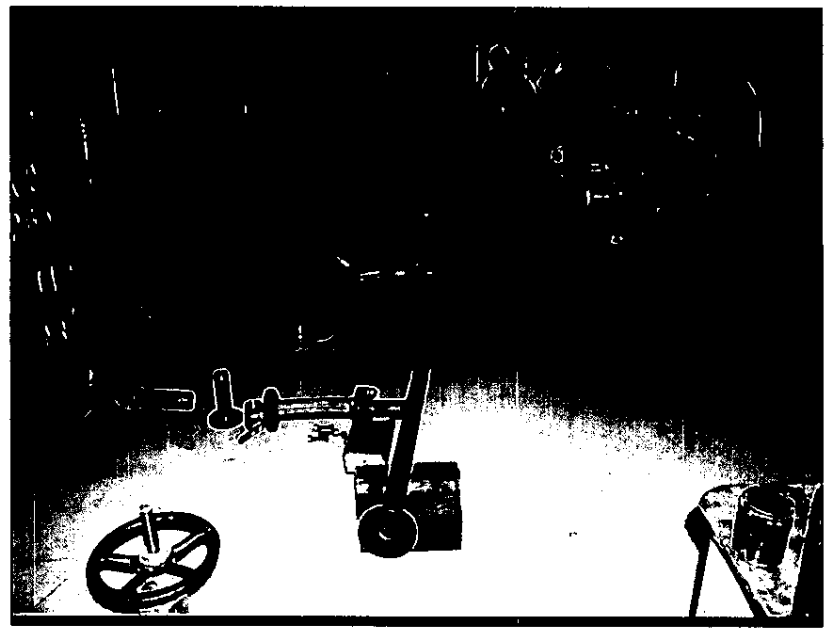




www.avtec.edu

AVTEC

Bulk Fuel Plant Operator

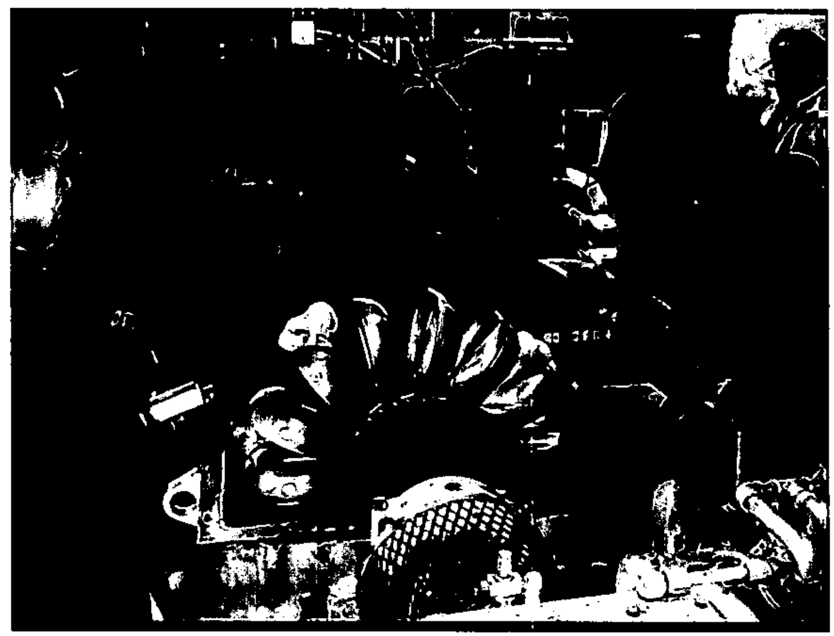


AVTEC students engaged in the classroom and in the field managing high efficiency bulk fuel systems

www.avtec.edu

AVTEC

Hydro Electric Plant Operator



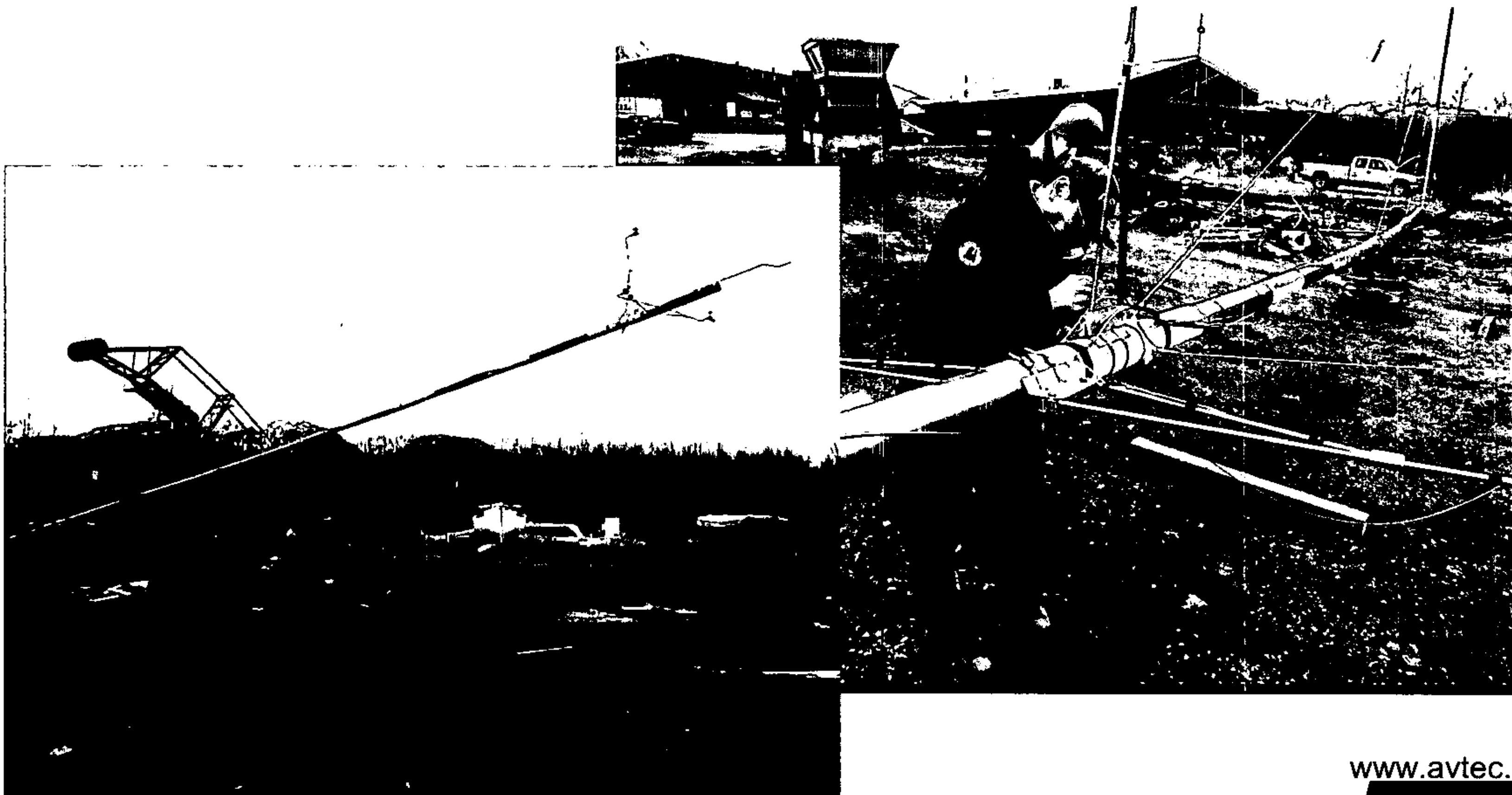
AVTEC Students participating with operator training at the City of Seward Hydro Plant

www.avtec.edu

AVTEC

Met Tower Installation

Studying Wind Energy at AVTEC's Seward Campus



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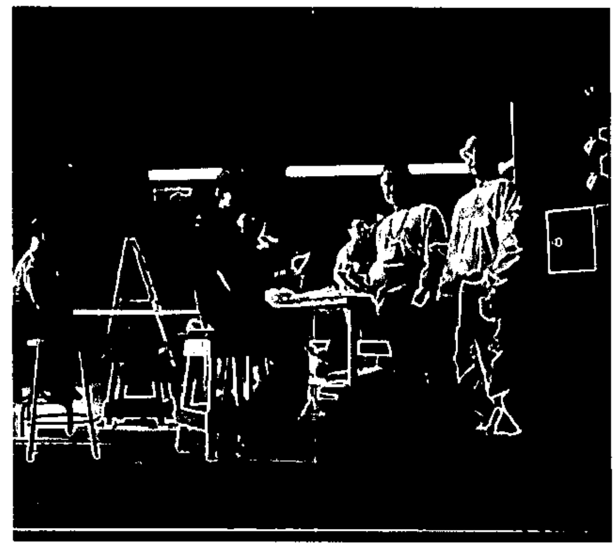
AVTEC

1291

Wind-Diesel Training Overview

INSTALLATION

ON-GOING
"HANDS-ON" O/M
TRAINING



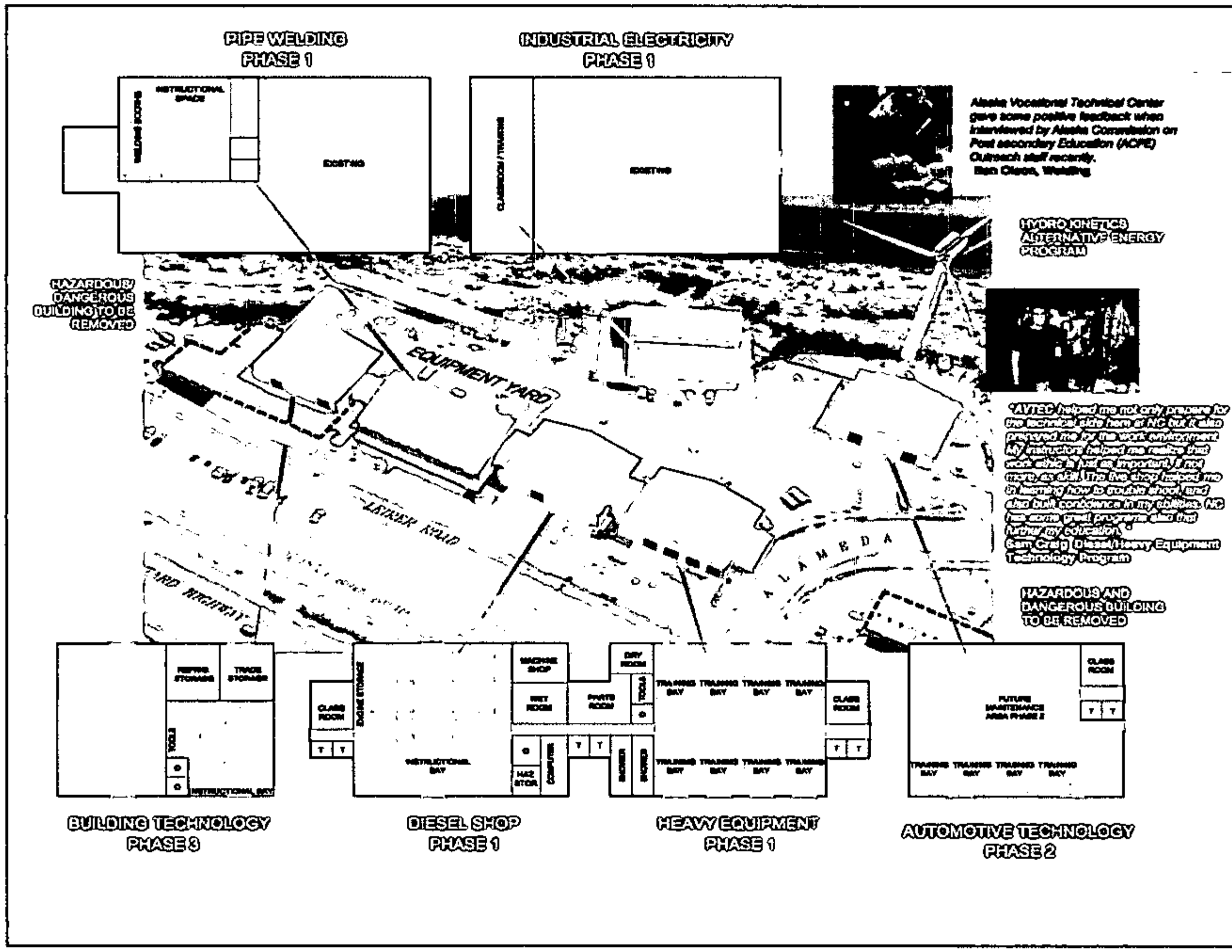
**WORLD CLASS WIND-DIESEL
OPERATOR TRAINING**

www.avtec.edu

AVTEC

1292

Wind Turbine Installation



Capital Improvement and Deferred Maintenance Plan

AVTEC

Applied Technology Campus

The applied tech campus is located at the industrial edge of town. These are the first AVTEC facilities seen by the public and this is where the vocational nature of AVTEC's programs are most evident. The location along the highway and railroad on the way into town makes this site an excellent opportunity to identify AVTEC and build interest for the diverse hands-on programs. Unfortunately this site includes well worn buildings that are in need of replacement due to age, condition and safety. There is in renewal an opportunity to have significant impact on program delivery, operational efficiency and image upgrade. Several projects are planned to make these programs competitive with up to date facilities.

FY10 Phase 1

Heavy Equipment / Diesel Shop
Pipe Welding Relocation
$ 12,000,000

This project has three significant parts that involve sequencing the relocation of programs. A new 18,000 SF pre engineered building will house the Heavy Equipment Program and Diesel Program. The Pipe Welding Program will move to the Diesel Shop and be adjacent to the Existing Welding program. This will also provide the requested adequate space for long pipe staging, storage and cutting. Relocating these programs will facilitate the demolition of the existing building which has Code,Life and Safety, and ADA Deficiencies.

Industrial Electricity Upgrade
$ 1,300,000

Improvements to this building include upgrade environmental systems and additional instructional space for increasing the student enrollment.

FY11 Phase 2

Automotive Technology Shop
$ 7,000,000

A new 8,000 SF preengineered building will house the Automotive Technology Program. This is the last program to move out of the existing building allowing the demolition of the existing building which has Code , and Life and Safety and ADA deficiencies. Work also includes the removal of a buried fuel tank and grading and paving the drainage away from the buildings.

FY12 Phase 3

Building Technology
Facilities Maintenance
Demolition of Existing Shop
$ 7,000,000

A new 8,000 Sf preengineered building addition for shared use by the Building Technology Program and Facilities Maintenance. This facility will replace the existing facilities maintenance building which has Code , and Life and Safety and ADA deficiencies

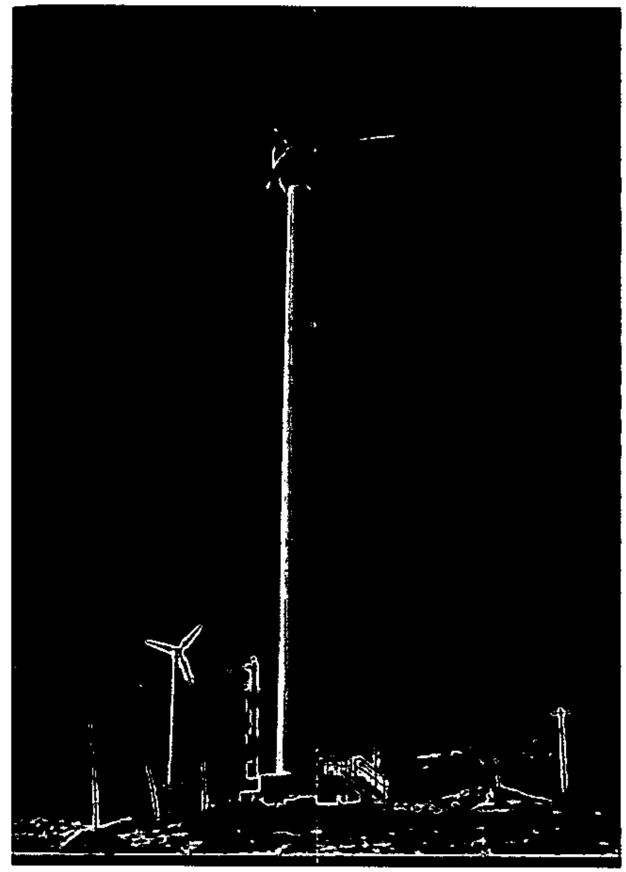
BDS
January 2009

du

AVTEC

Wind-Diesel Training Objectives

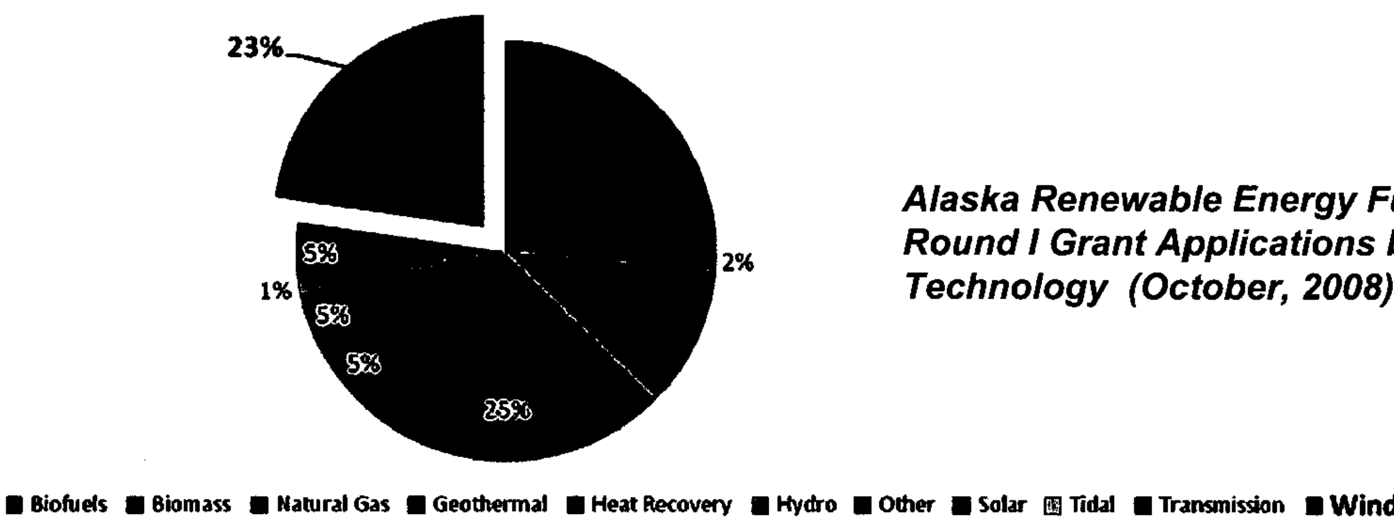
- Establish a world-class wind-diesel program that supports the interests of stakeholders from across Alaska
  - Wind-Diesel System Owners/Operators
  - Rural Alaska Electricity Cooperatives
  - Alaska Energy Authority
- Create “hands-on” educational opportunities through an on-campus wind-diesel installation
- Utilize standardized, proven, and relevant technologies for Alaskan applications



1294

Wind-Diesel Program Benefits

- Currently, no wind-diesel training programs exist within the state of Alaska
  - Approximately 20 unique utility scale wind projects are currently in operation across Alaska
  - Alaska's Renewable Energy Fund will support a significant number of new wind energy projects



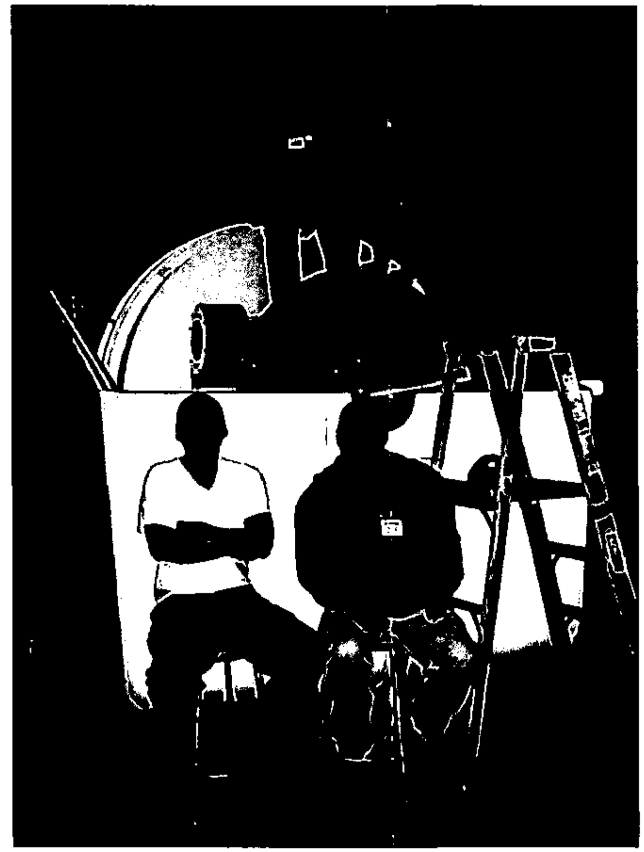
Alaska Renewable Energy Fund Round I Grant Applications by Technology (October, 2008)

1295

Wind-Diesel Program Benefits

- Historically, rural Alaskan wind-diesel system operators have been sent out of state to receive necessary training

- AVTEC Program will be based on successful training program already established by Alaska's largest wind energy system owner (AVEC)



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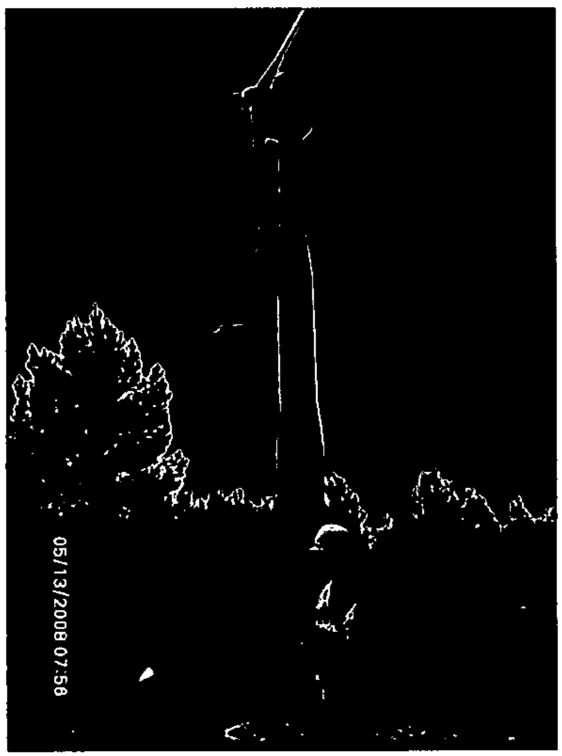
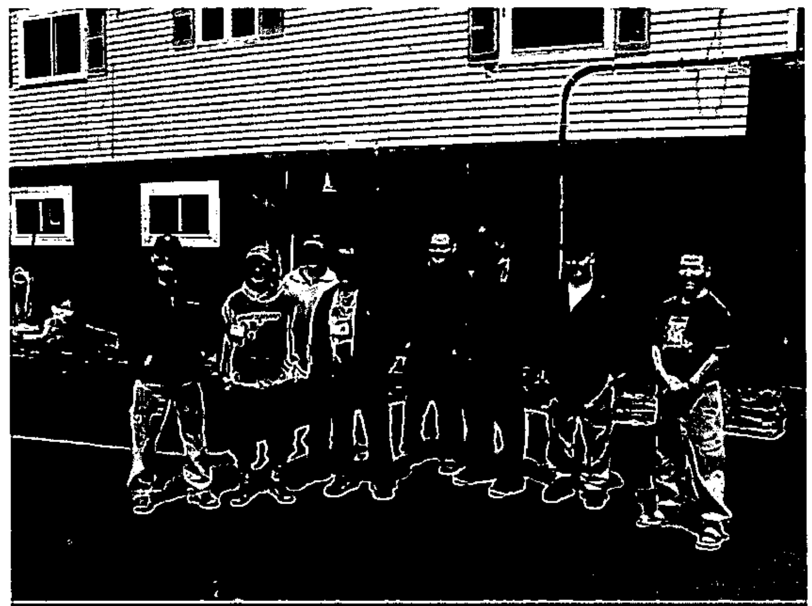
1296

Wind-Diesel Program Benefits

- Alaska based program will significantly reduce training costs while providing opportunities for expanded curriculum (introduction, intermediate, advanced, etc.)





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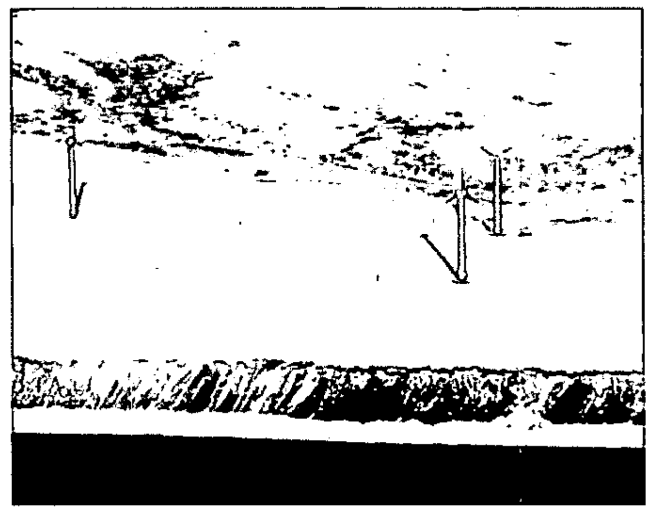
AVTEC

Wind-Diesel Program Benefits

- Operating cost reduction at the school's industrial electricity facility
- Total net energy production estimates are 100,756 kWh annually which would save AVTEC approximately $7,300 each year based on current electricity rates



www.avtec.edu

AVTEC

2-26-09 Alternative Energy in Arctic and Subarctic Alaska

<target><bill></bill><subject>2-26-09 Alternative Energy in Arctic and Subarctic Alaska</subject><comm>SWTR26</comm></target>

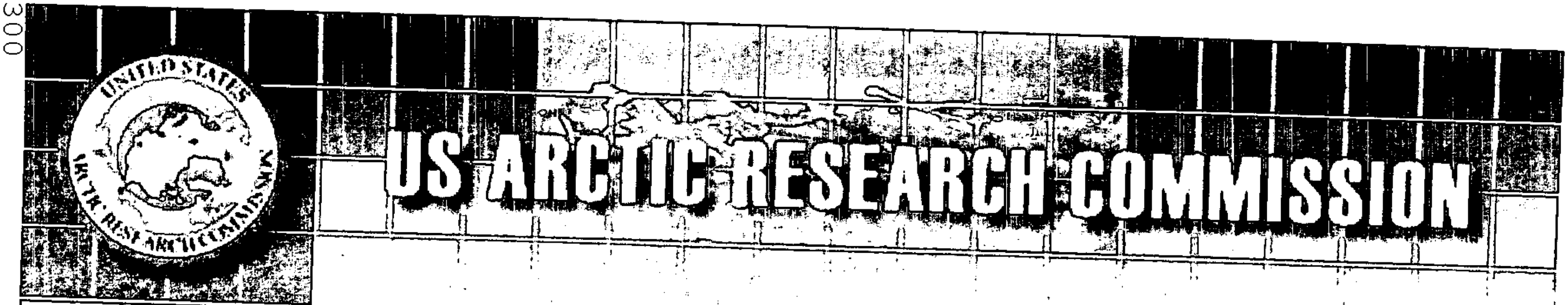
1299

New Energy: The U.S. Arctic Research Program and Alaska

Mead Treadwell, Chair
U.S. Arctic Research Commission

Slides accompanying testimony to the Alaska Senate Special Committee on World Trade, Technology, Innovation

Juneau, Alaska – February 26, 2009




Mead Treadwell, Chair


Michele Longo Eder


Helvi Sandvik


Virgil (Buck) Sharpton


Vera Kingeekuk Metcalf


Warren Zapol


Charles Vörösmarty

Arctic Research in the US

- The U.S. Arctic Research Program is approximately $400 million per year…across at least 15 federal agencies…cooperating with over a dozen nations …using research infrastructure worth billions…and building America's competitive position

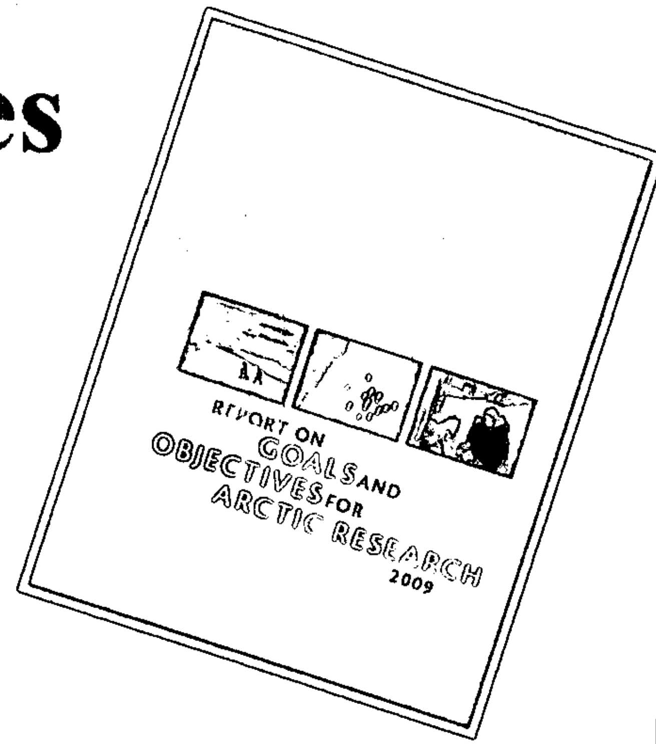
UNITED STATES ARCTIC RESEARCH COMMISSION



REPORT ON GOALS AND OBJECTIVES FOR ARCTIC RESEARCH 2009

1303

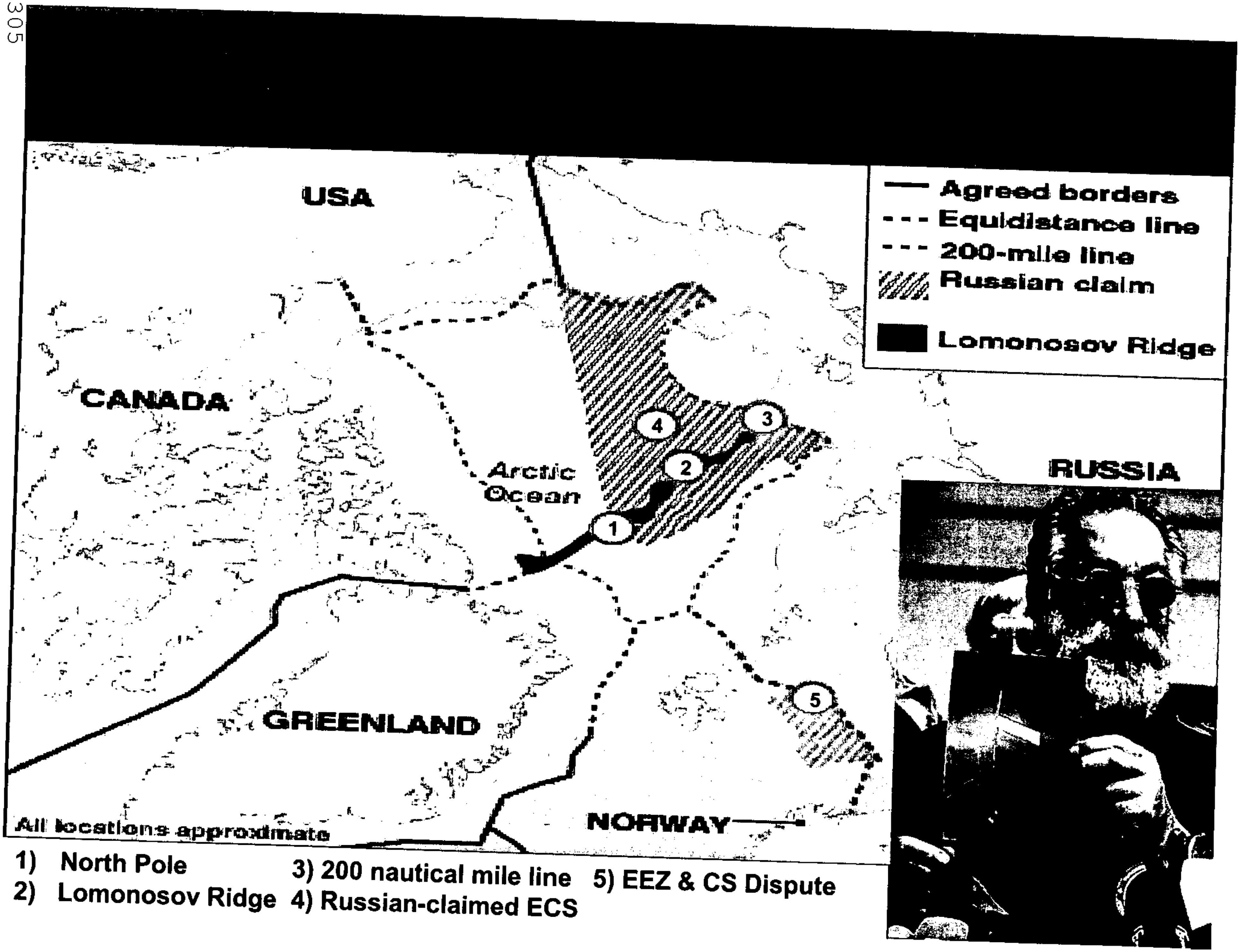
Research Themes



- Environmental Change of the Arctic & Bering Seas
- Arctic Human Health
- Civil Infrastructure
- Natural Resource Assessment & Earth Science
- Indigenous Languages, Identities, Cultures

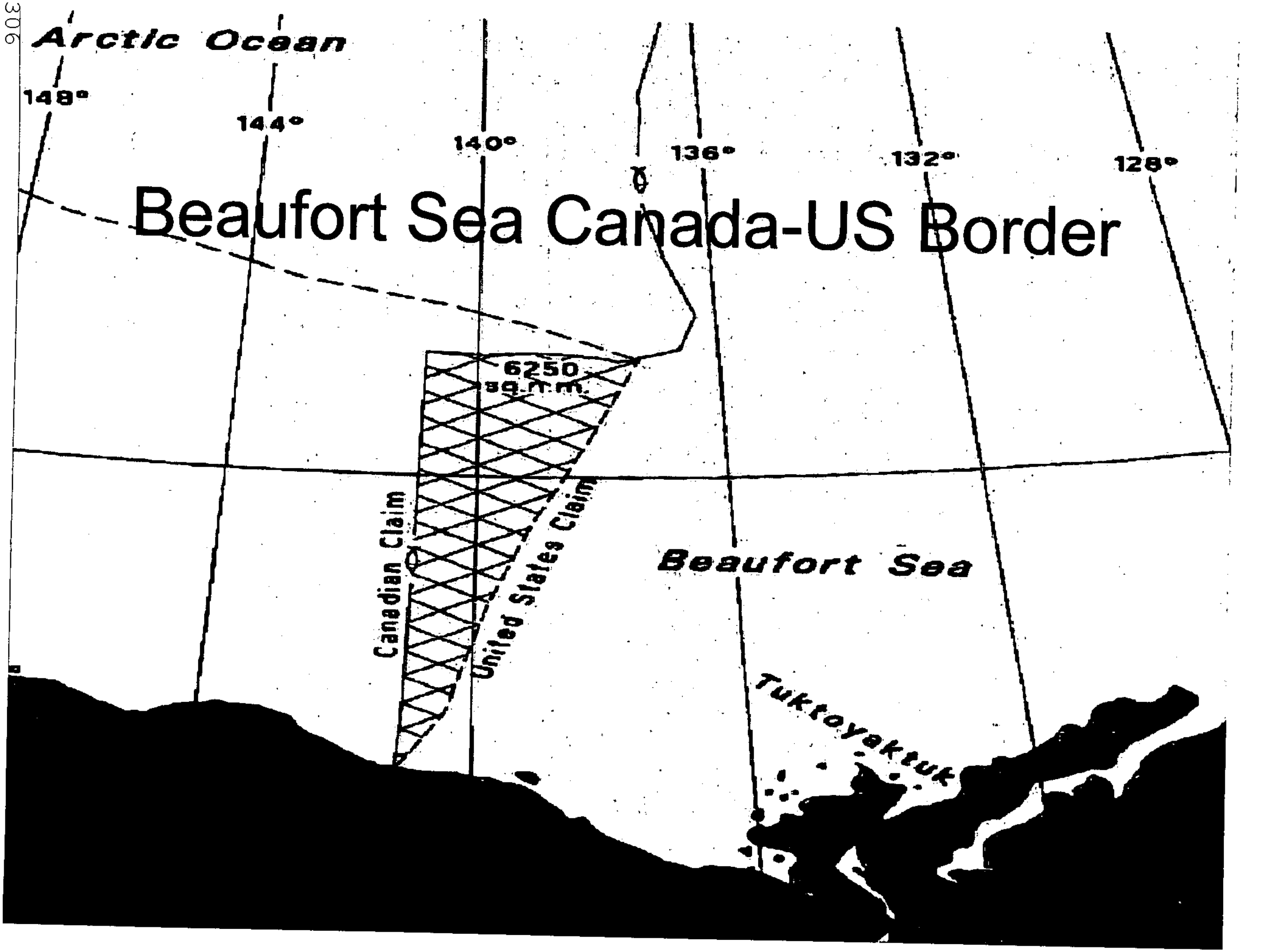
New US Arctic Policy

- National security/homeland security needs
- Protect environment/conserve biological resources
- Environmentally sustainable resource management and development
- Strengthen institutions for international cooperation; ratify Law of the Sea
- Involve indigenous communities in decisions
- Enhance scientific monitoring and research into local, regional and global environmental issues



1) North Pole
2) Lomonosov Ridge
3) 200 nautical mile line
4) Russian-claimed ECS
5) EEZ & CS Dispute

Beaufort Sea Canada-US Border



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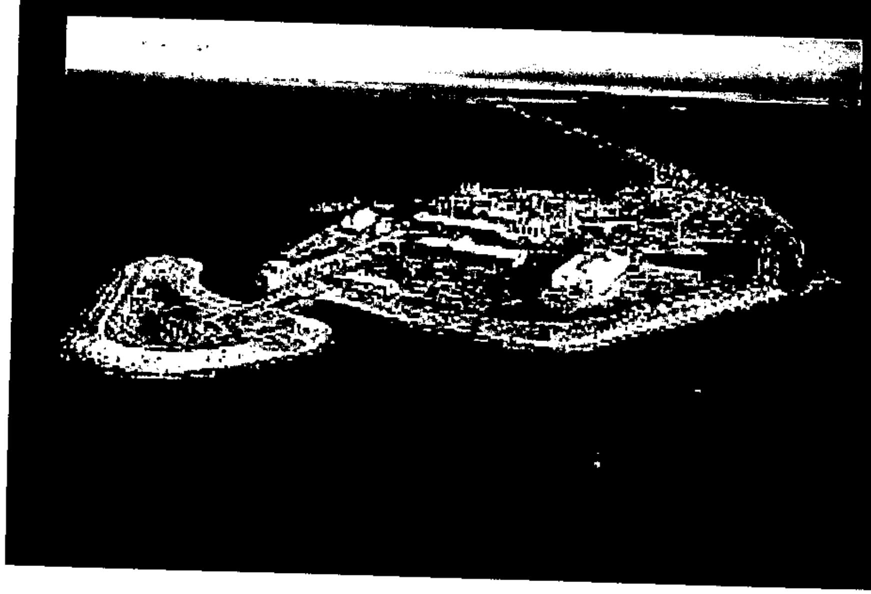
1307

UNITED STATES ARCTIC RESEARCH COMMISSION

INSTITUTE OF THE NORTH

THE ARCTIC ENERGY SUMMIT

AN INTERNATIONAL POLAR YEAR EVENT



ARCTIC ENERGY
Themes

RURAL

EXTRACTIVE

SUSTAINABILITY

New Energy

- Arctic energy research in Alaska has global implications
  - Safer, more efficient fossil fuel development
    - New exploration techniques, onshore and offshore
    - Longer winter drilling seasons in a warming climate
    - Improvements in cold weather spill prevention, response
    - Safe, secure, reliable shipping
    - Carbon sequestration, use of gas hydrates

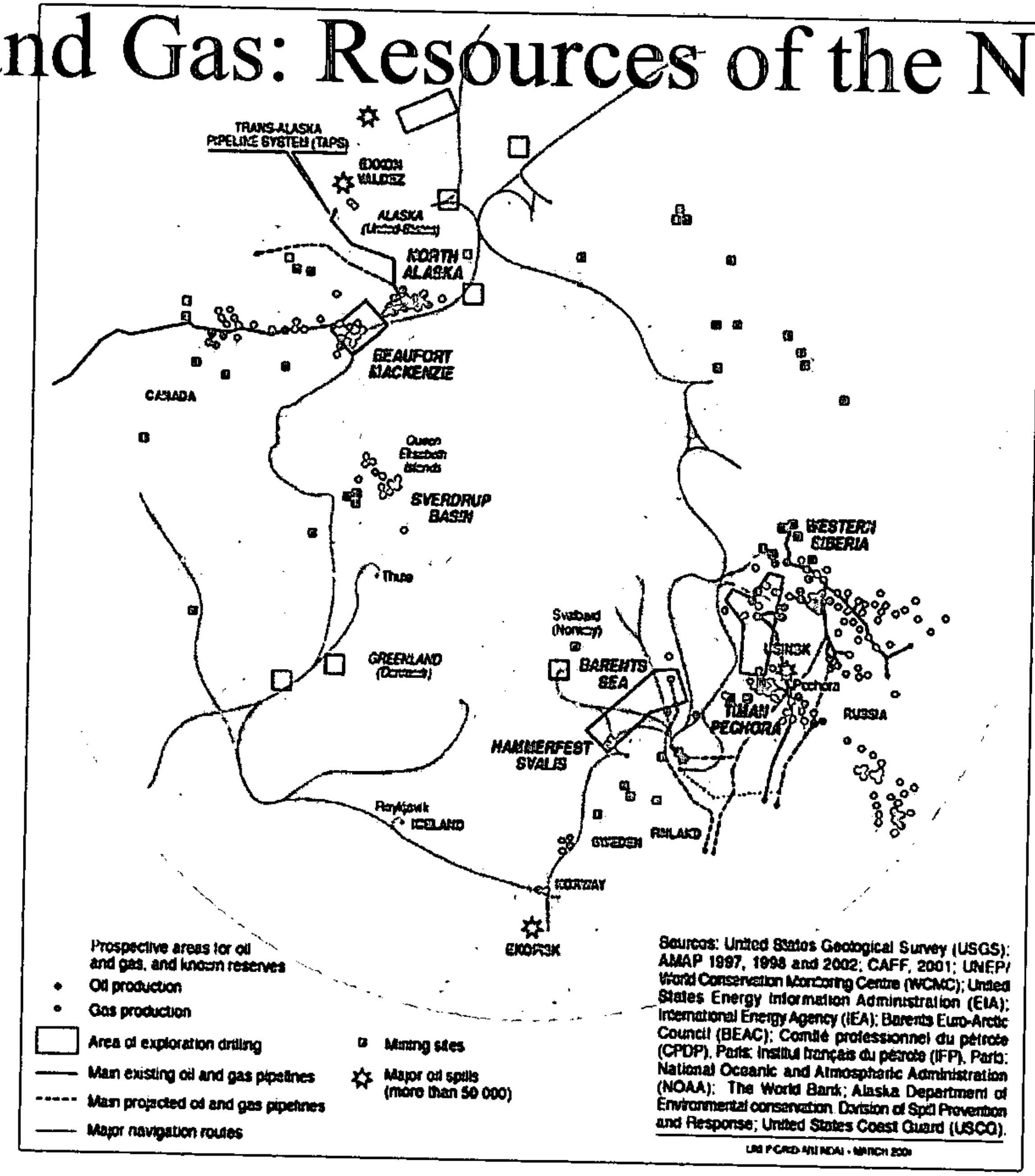
1309

New Energy

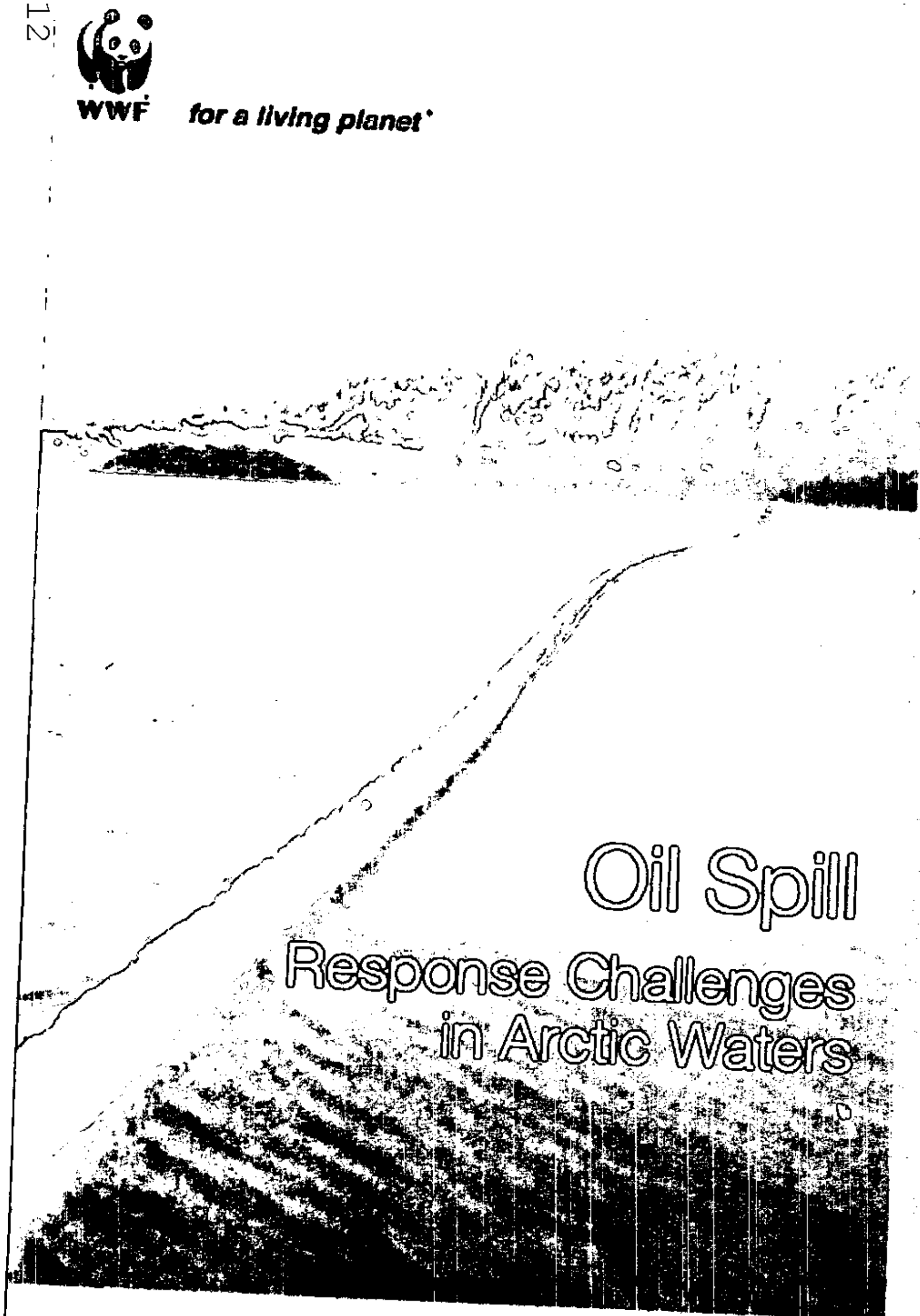
– Our motivation can be stabilizing costs AND mitigating global climate change
  - Our focus can be rural AND urban AND export
  - Onshore and offshore
  - Electric power, heat, and all transport modes
  - Alaska's natural assets include hydro, wind, tides, geothermal, waves, biomass, solar…
  - Arctic may be a "geoengineering" venue as well
  - Alaska may play in new transport routes as well


PETROLEUM POTENTIAL OF ASSESSMENT UNITS AND PROVINCES IN THE CIRCUM-ARCTIC
In the Circum-Arctic Resource Appraisal (CARA), 33 provinces were examined, of which 25 were judged to have a 10-percent or g
or probability of at least one significant undiscovered petroleum accumulation in any constituent assessment unit (AU) and were th
fore quantitatively assessed. Shown in these three maps are the relative probabilities for all assessment units assessed and the estimat
relative potentials for undiscovered oil and gas in the assessed province.
PROBABILITY
(percent)
100
50–100
30–50
10–30
<10
Area of low petroleum

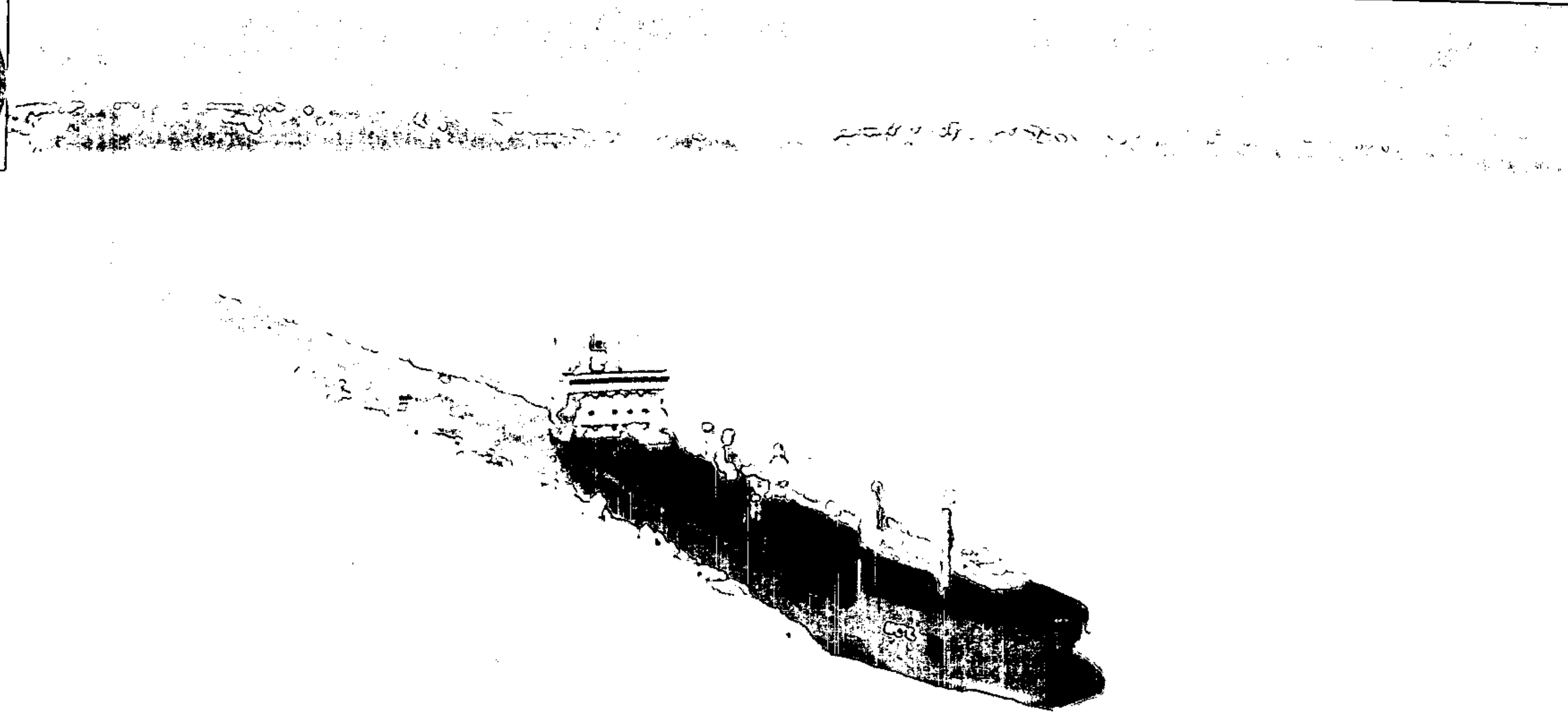
Oil and Gas: Resources of the North



Source: AMAP



- Federally supported oil in ice research continues, in international programs, supported by several agencies

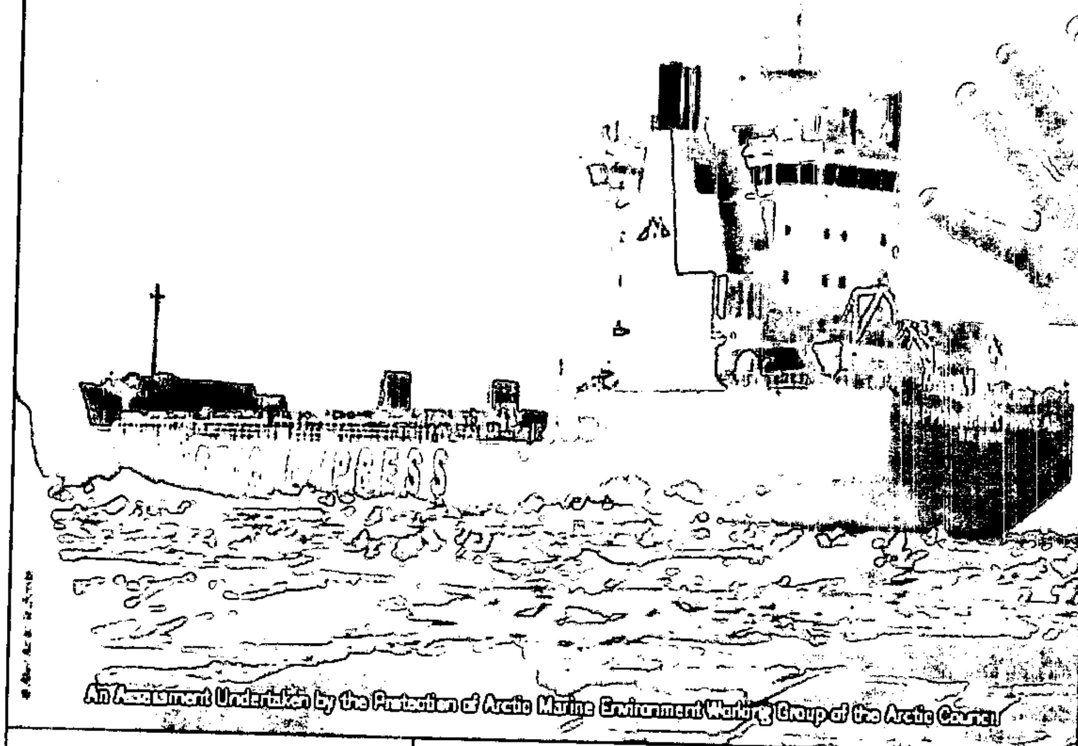


"Demand for ice-class tankers has been steadily rising as oil exports from Russia's Arctic regions become ever more attractive. The ordering pace…in the tanker industry… (reached) some $4.5 billion in (2004) alone."

--American Bureau of Shipping, *Surveyor*, Summer 2005

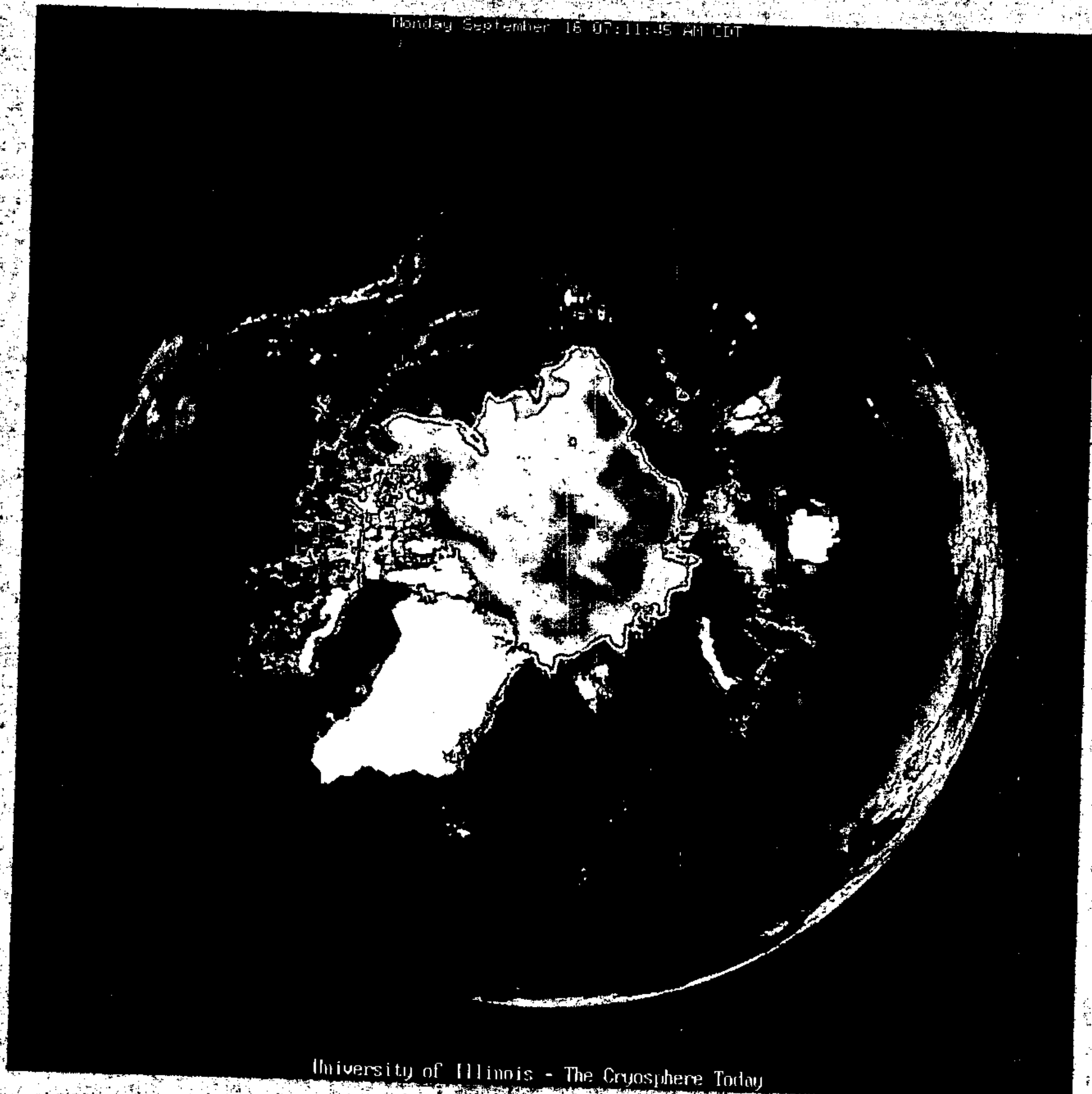
1314

ARCTIC MARINE SHIPPING ASSESSMENT



PAME

16 September 2002



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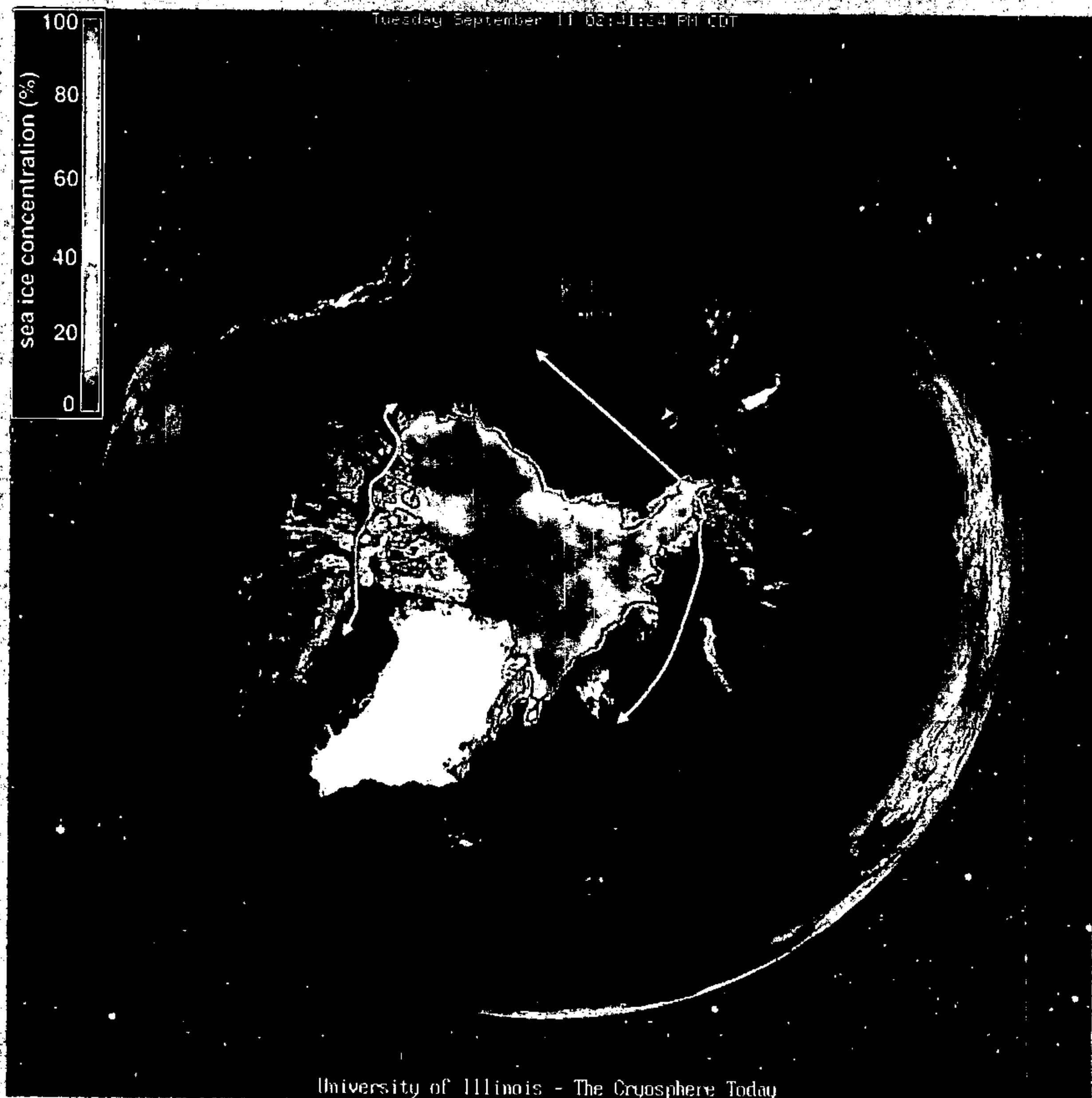

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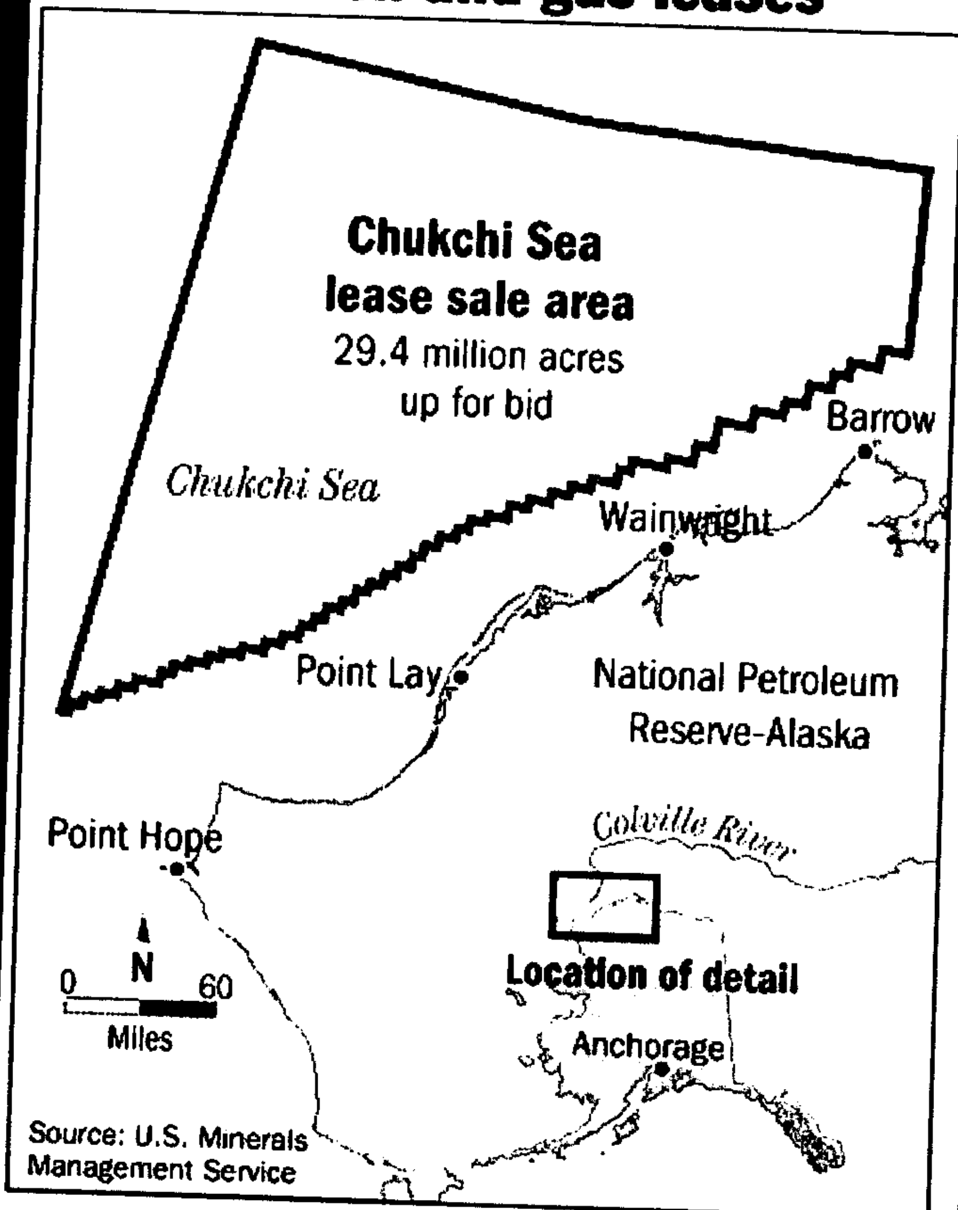
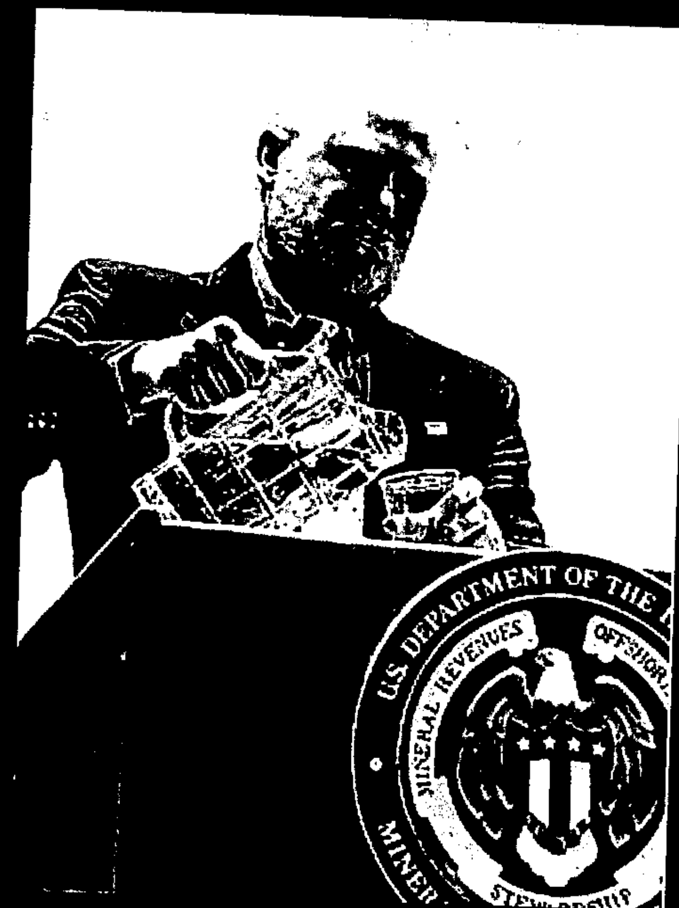
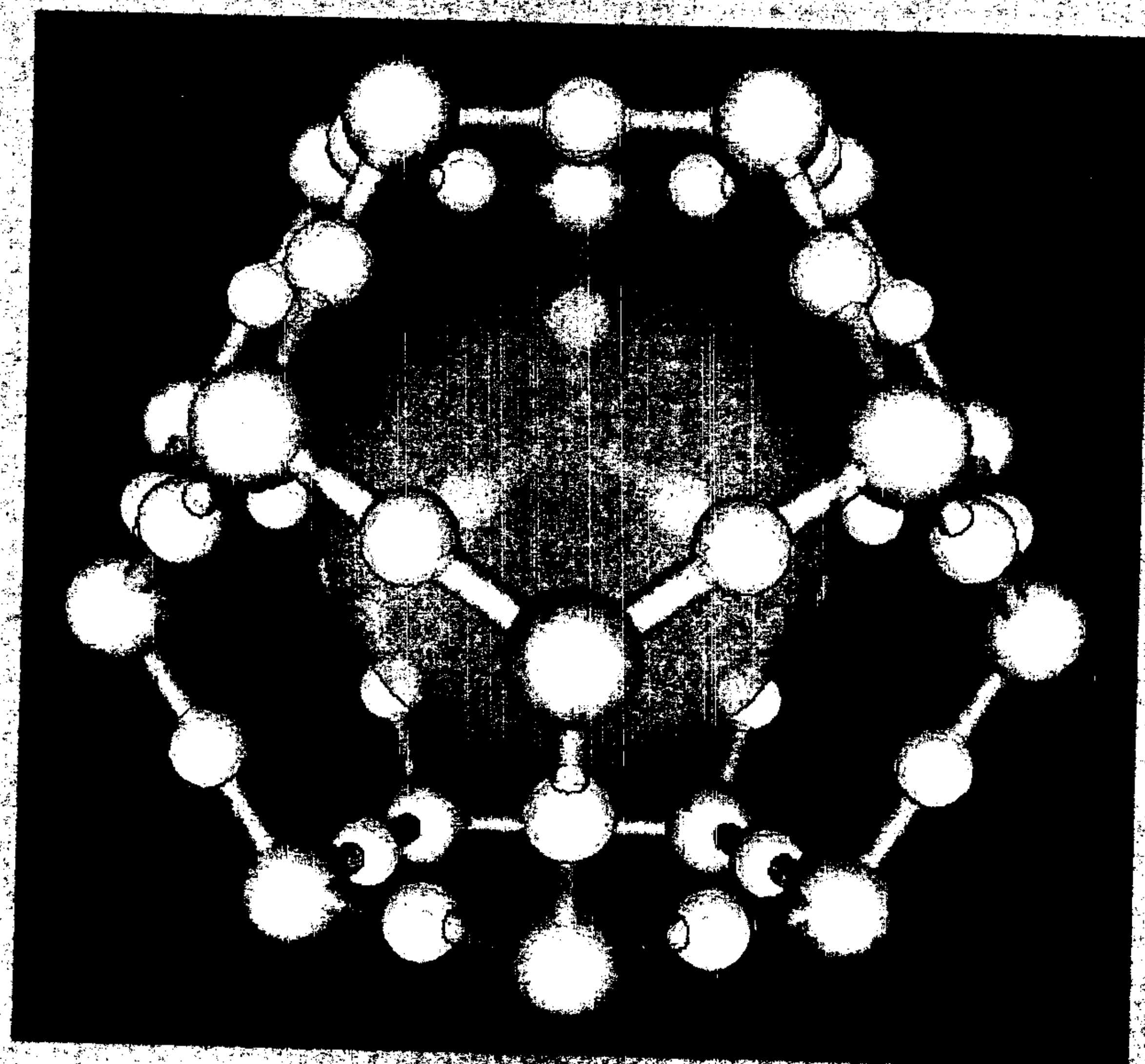
Record $2.7 billion bid for Alaska oil and gas leases

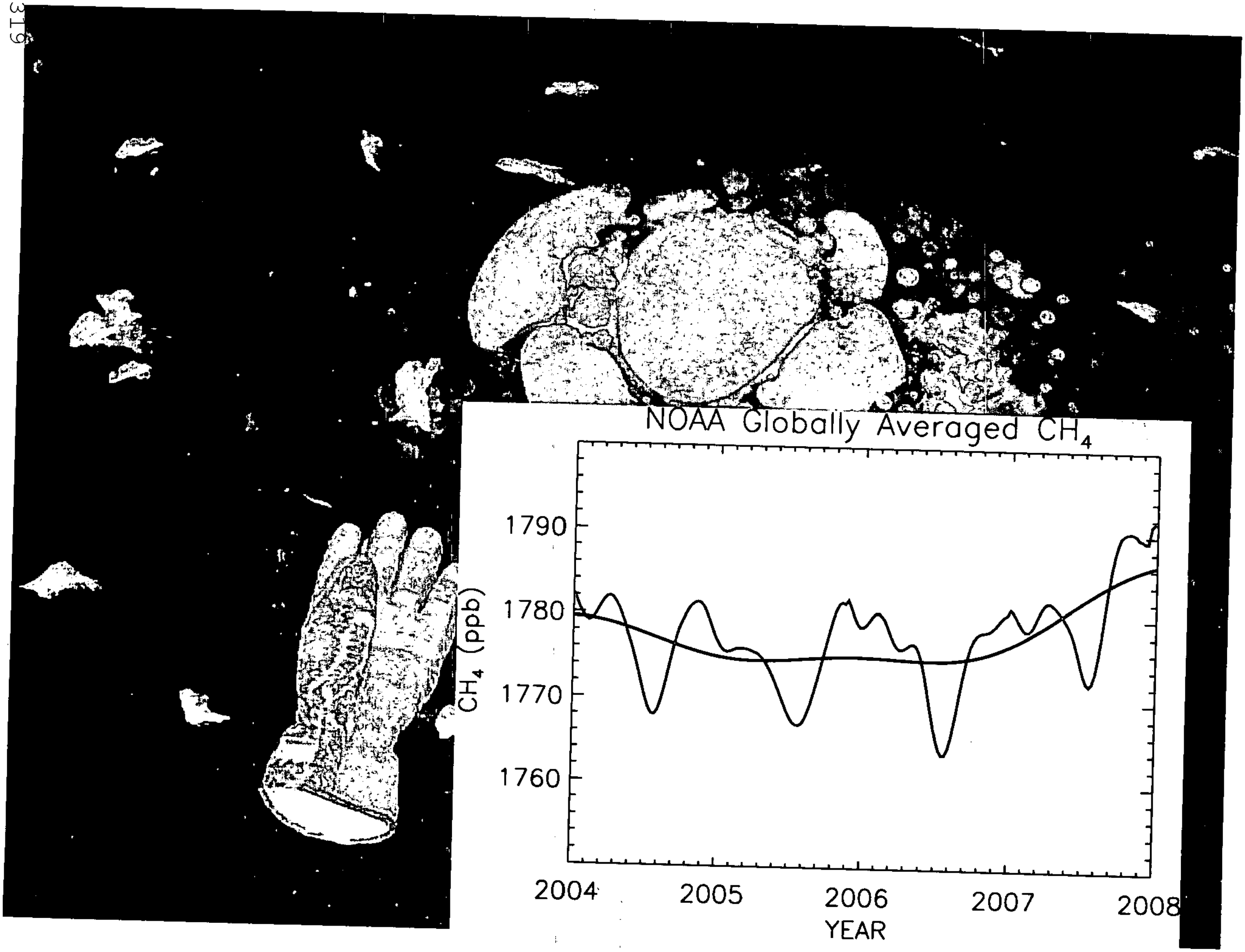


RON ENGSTROM / Anchorage Daily News



Gas Hydrate Research





NOAA Globally Averaged CH_4
CH_4 (ppb)
1790
1780
1770
1760
2004
2005
2006
2007
2008
YEAR

DOE/PI-0005

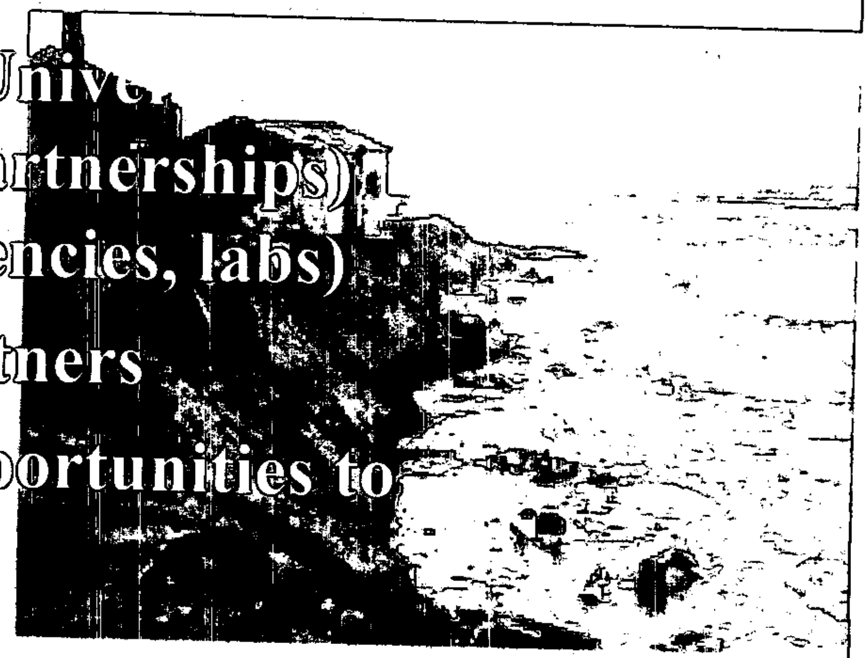
U.S. Climate Change Technology Program

STRATEGIC PLAN

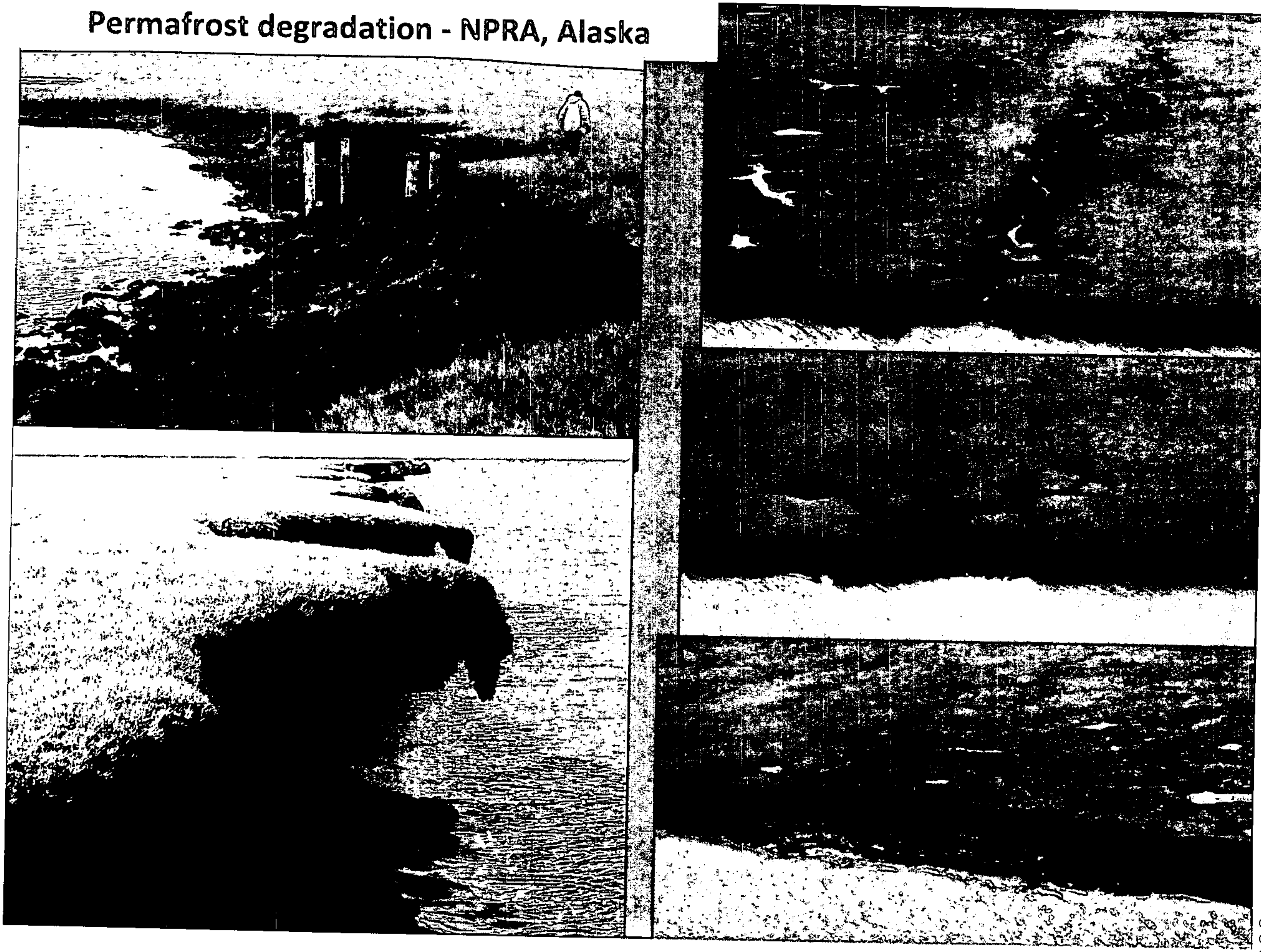
September 2006

1321

- How do we develop a research plan?
  - Convene experts
  - Find clients (resource managers, builders, lenders, insurers)
  - Extramural (Competitive Unive research; Public-Private Partnerships) vs. Intramural (Federal agencies, labs)
  - International and state partners
  - Pilot projects and other opportunities to test



Permafrost degradation - NPRA, Alaska



Statewide Housing Condition

- Mean household unit – 1,507 square feet
- Median household unit – 1,300 square feet
- Average sq ft per resident (mean) – 634
- Average sq ft per resident (median) - 500
- No running water – 10 %
- Trouble maintaining temperature – 26 %
- Drafty – 44.7 %

Source: AHFC 2005 Alaska Housing Assessment

Housing Findings

- % of older housing (21+ years) increasing
- % of new housing (0-10 years) decreasing
- Average cost of single-family unit by region ranges from $172k to $266k
- 45,000 households estimated to be income eligible for weatherization services

Source: AHFC 2005 Alaska Housing Assessment

Statewide Housing Need

- More than 25,000 new housing units needed
- Cost to replace units that are substandard and not salvageable is **$873 Million**
- Cost to alleviate overcrowding for homes with 200 square feet or fewer per resident is approximately **$4.78 Billion** dollars
- Total cost to replace, repair and alleviate crowded conditions is **$5.99 Billion**

Source: AHFC 2005 Alaska Housing Assessment

Shorter Shipping Distances

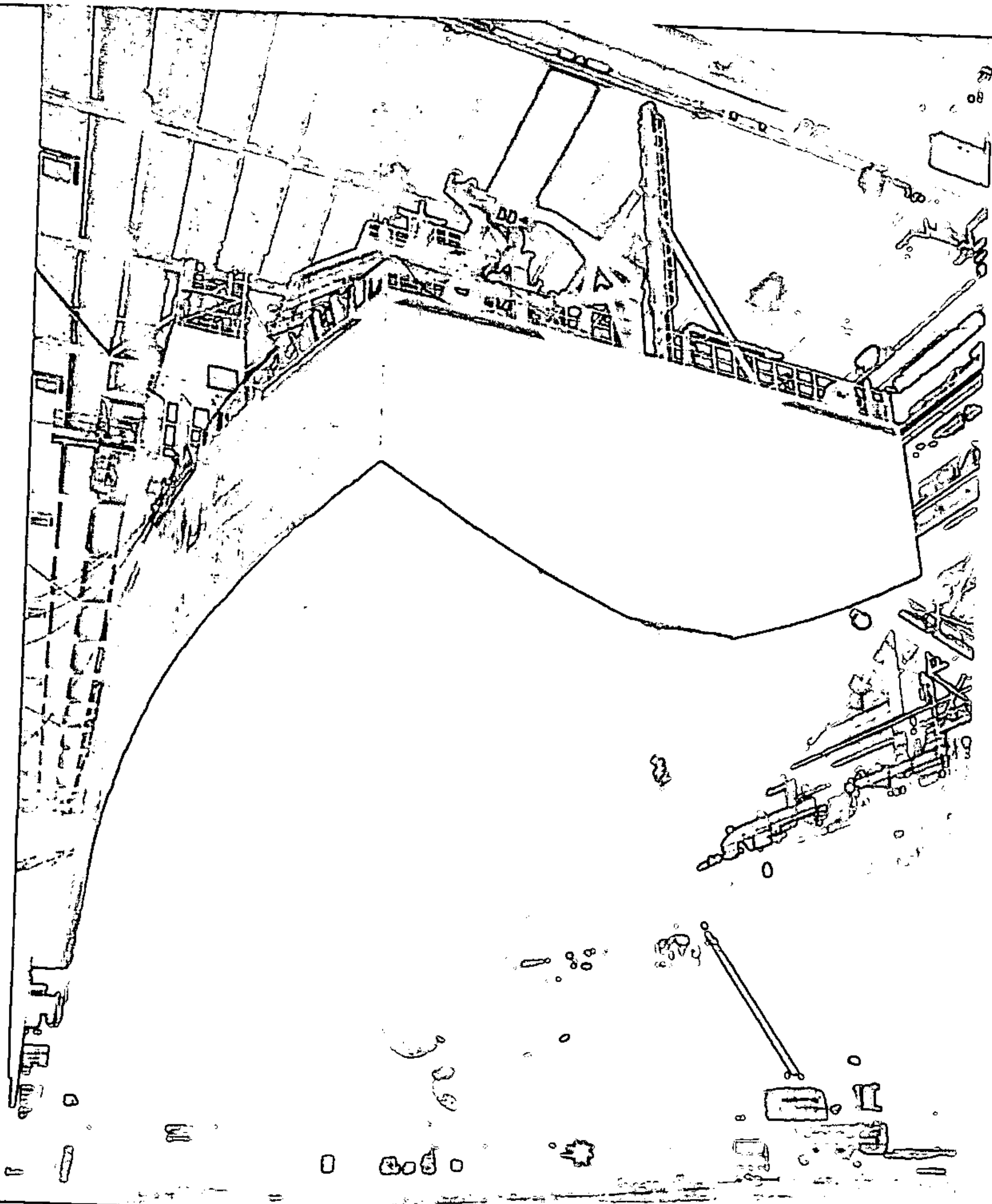
**Distance:
Hamburg
to Yokohama
(nautical miles)**

**Northern Sea
Route ~ 6,920**

**Suez Canal ~
11,073**

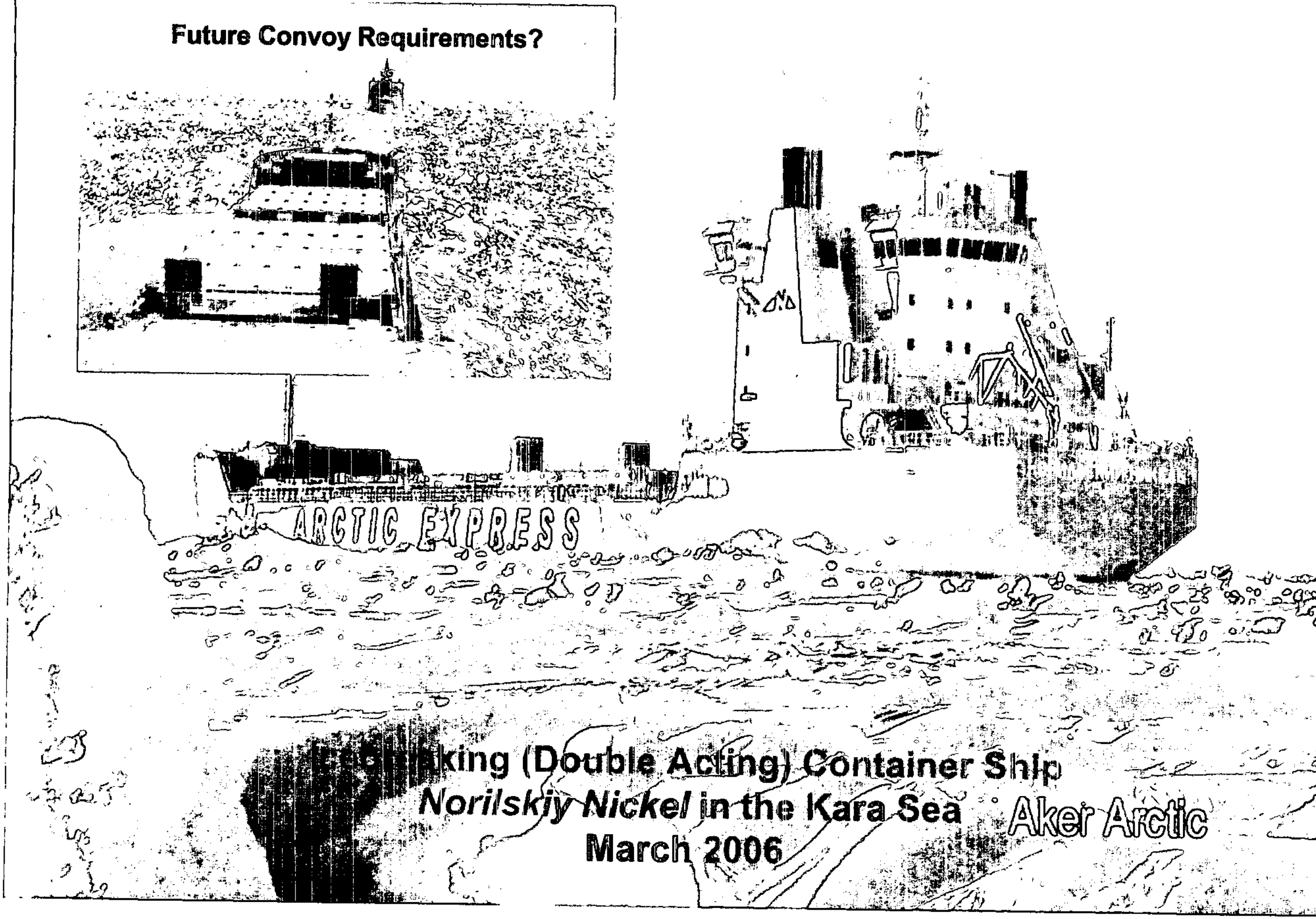
**Panama Canal ~
12,420**

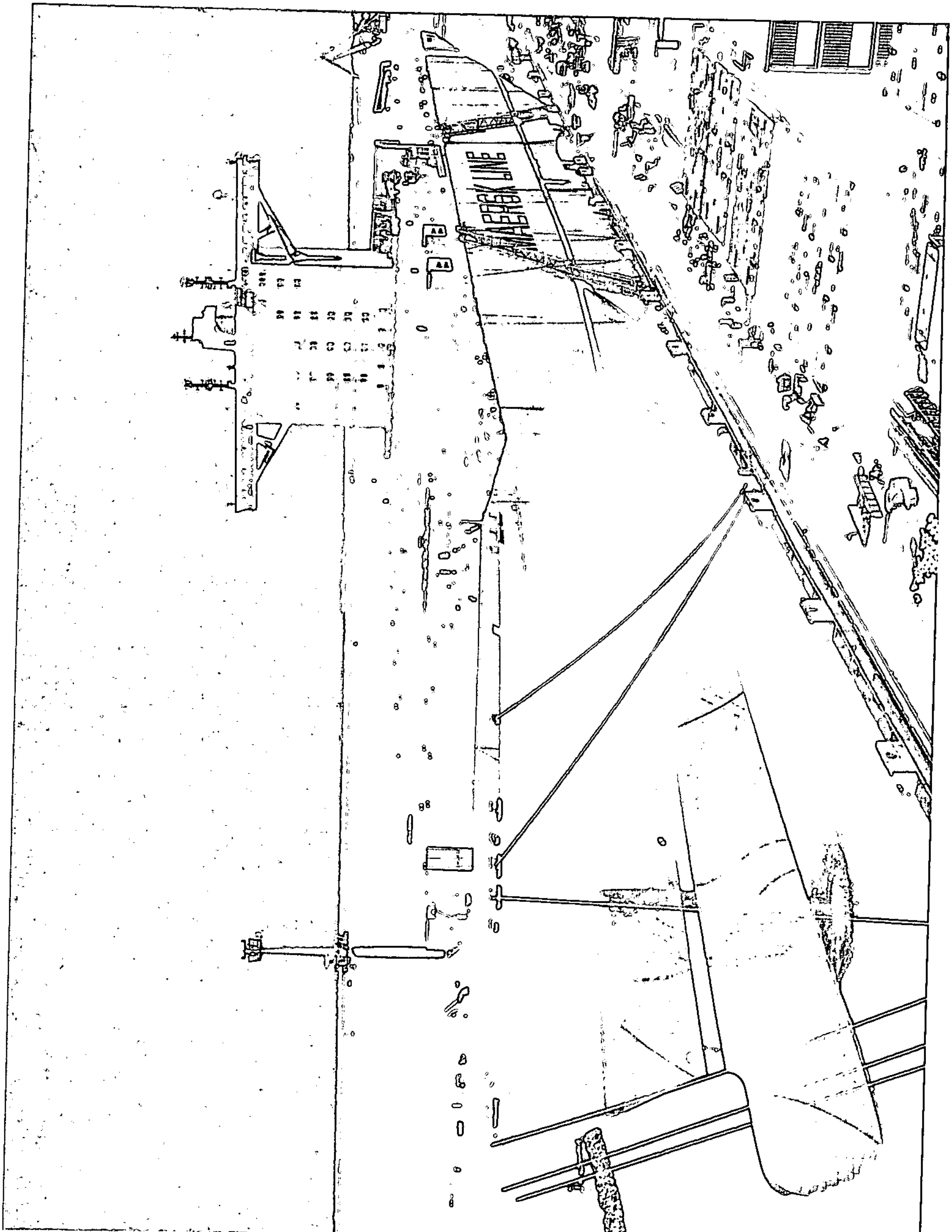
**Cape of Good
Hope ~ 14,542**



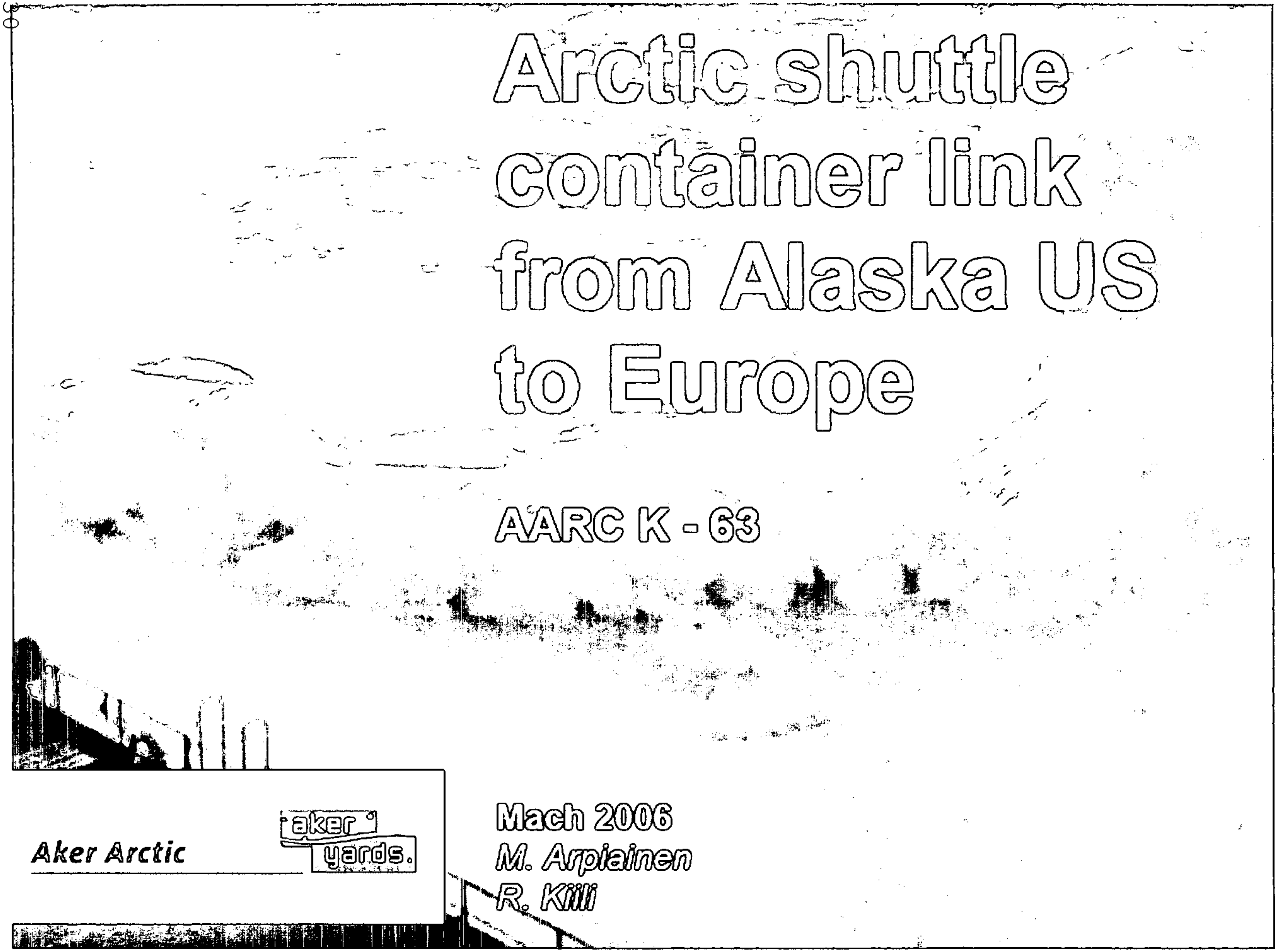
Aker Arctic
Technology

Icebreaker Design for Greater Efficiency




MAERSK LINE

1330



Arctic shuttle container link from Alaska US to Europe
AARC K - 63
Mach 2006
M. Arpiainen
R. Kiili
Aker Arctic
aker yards.

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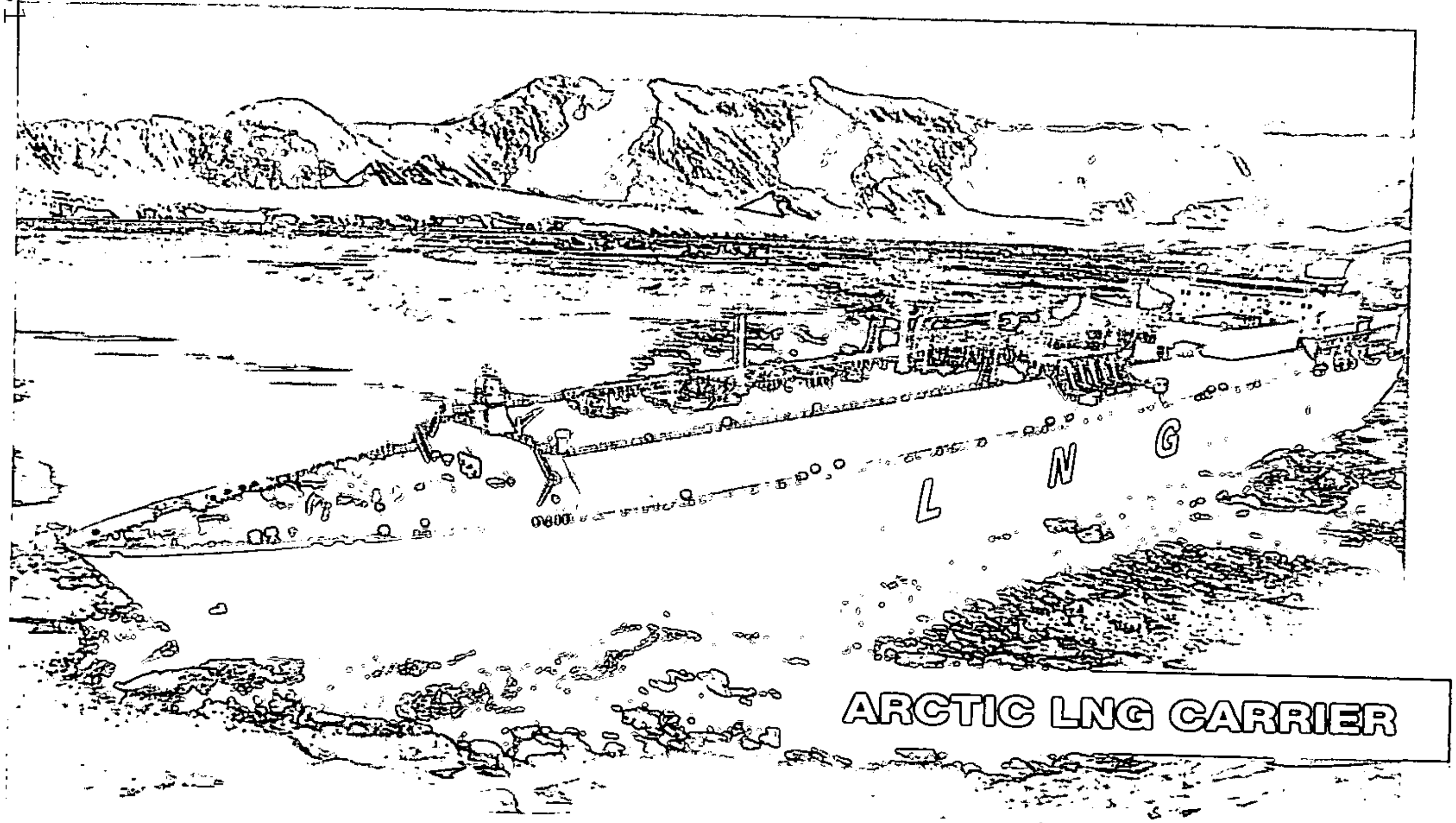


ARCTIC LNG CARRIER OVERVIEW

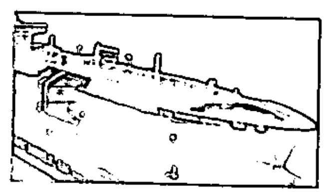
• Ice Class	Baltic Ice 1A / RMRS LU4
• Winterization	Extreme Low Air -40 C
• CCS	Reinforced Mk-III, Combi. or SPB
• Trading Route	Russia/Baltic Sea – USA/Europe

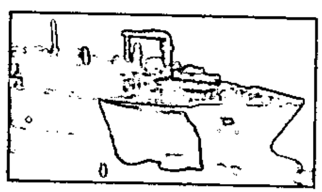
HULL FORM & PERFORMANCE VERIFICATION

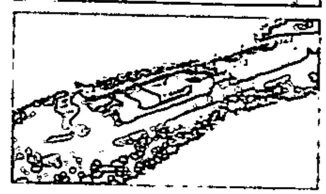
- Ice Collision Dynamic Motion Analysis & Test
- Sea-keeping Analysis under harsh condition
- Speed in Ice and Open water

RELIABLE STRUCTURE DESIGN

- Structural Safety Assessment with Krylov
- Cargo Containment System Safety Assessment with GTT
- Ice Collision Simulation & Test







So

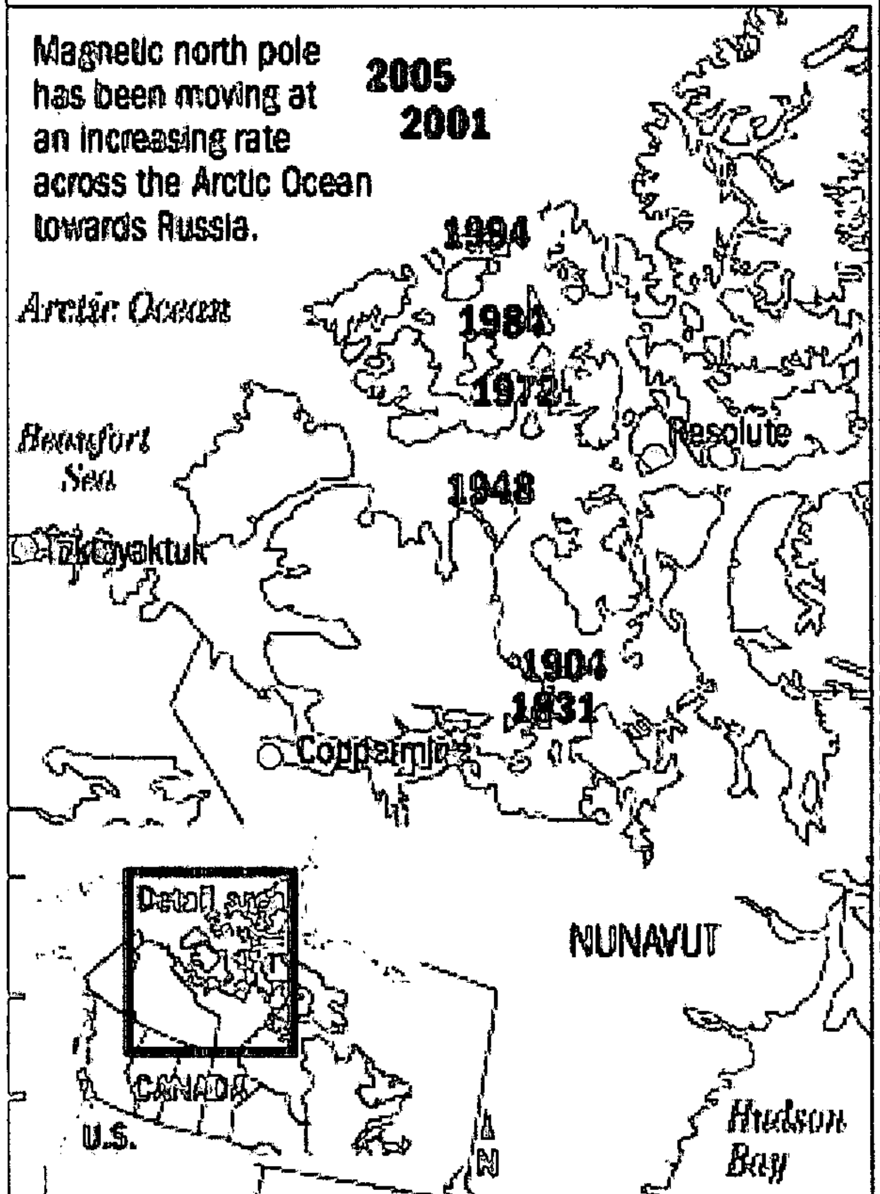
He

USARC ECUMENICAL BELIEF

- The United States must maintain its global maritime capability—as a government AND as a Nation
- If the U.S. does not exercise its visible maritime presence in the Arctic Ocean—we cede it to whomever wants it!

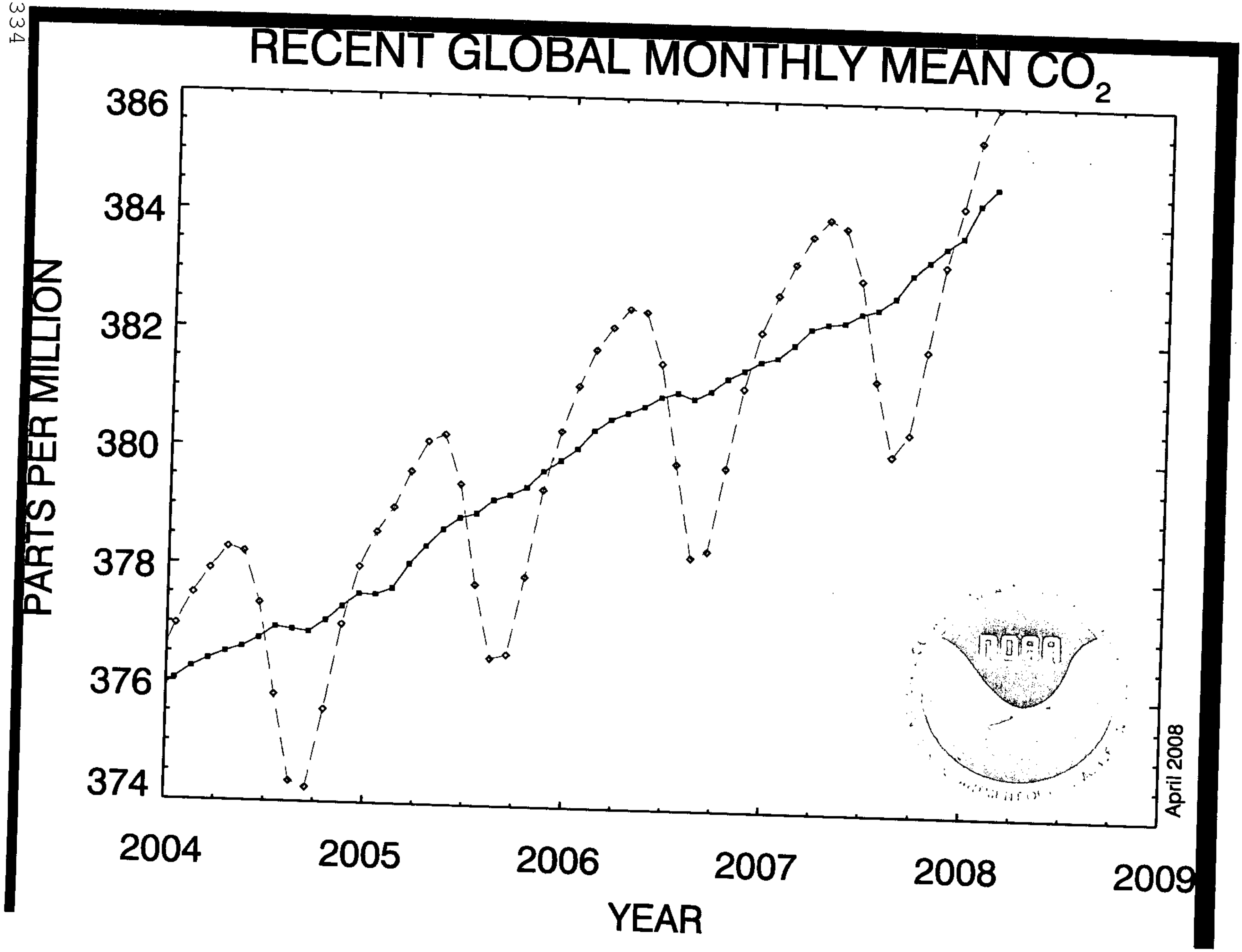
UNITED STATES ARCTIC RESEARCH COMMISSION

Shifting magnetic north pole



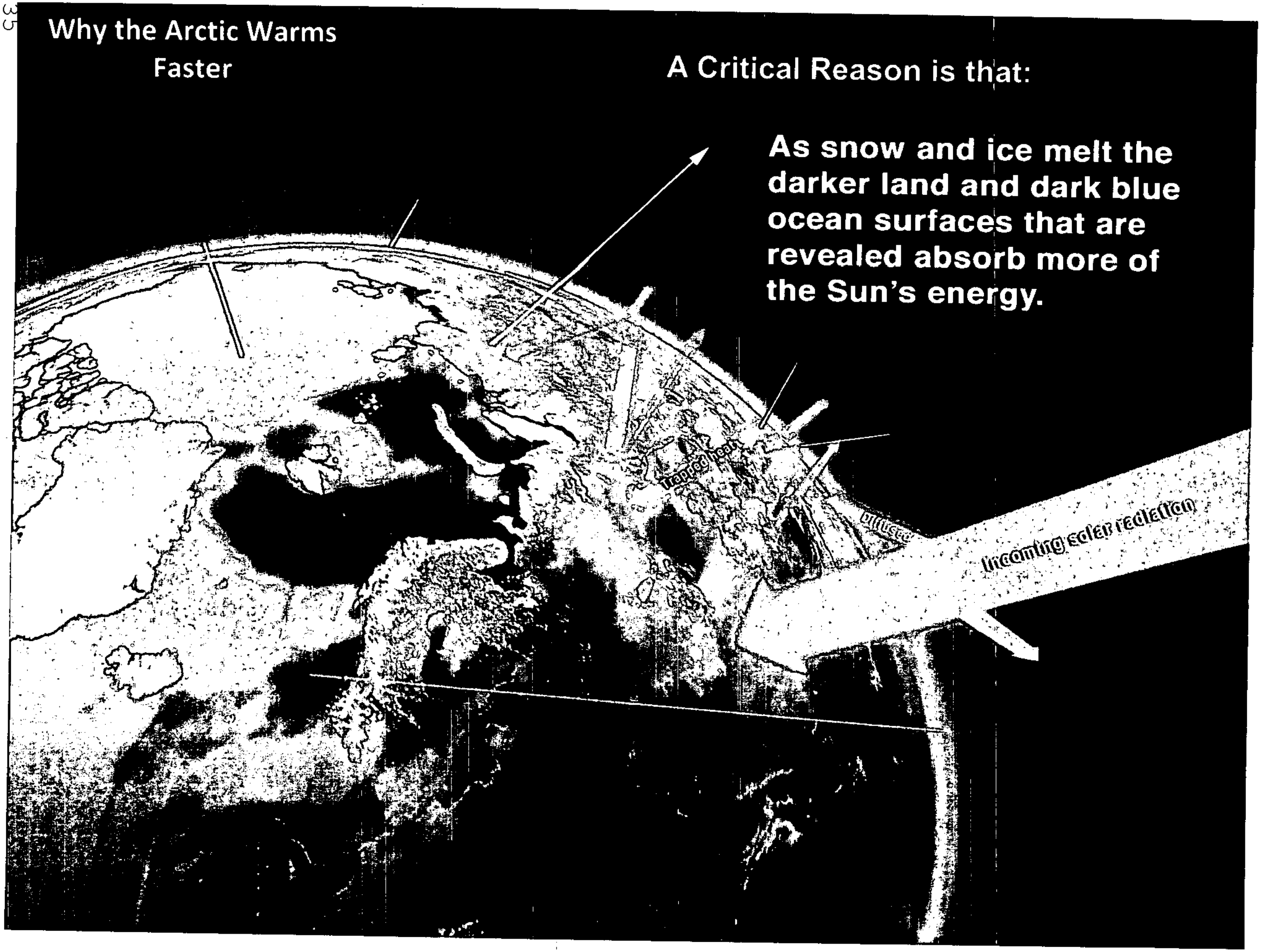
CHARLES ATKINS / Anchorage Daily News

1334



RECENT GLOBAL MONTHLY MEAN CO_2
PARTS PER MILLION
386
384
382
380
378
376
374
2004
2005
2006
2007
2008
2009
YEAR
April 2008

1335


Why the Arctic Warms
Faster
A Critical Reason is that:
As snow and ice melt the darker land and dark blue ocean surfaces that are revealed absorb more of the Sun's energy.
Trapped heat
Incoming solar radiation

To Polar Explorers, Godspeed!

INTERNATIONAL POLAR YEAR
2007-2008

UNITED STATES
ARCTIC RESEARCH COMMISSION

http://www.ipy.org

www.arctic.gov

www.us-ipy.org

www.us-ipy.gov

UNITED STATES ARCTIC RESEARCH COMMISSION

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INSTITUTE OF THE NORTH

Why the Arctic Matters:

The Potential Contribution of Arctic Research to U.S. Climate Change Mitigation Strategy

A report submitted to the U.S. Arctic Research Commission

February 2008

Prepared by

Sarah Dewey

and Dan Wilson

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Introduction

There is now a wide consensus in the scientific community that this century will see average global temperatures rise by anywhere from 1.1° to 6.4° C.[1] That will be in addition to the 0.6° C rise during the last century.[2] Within the past decade, it has become increasingly clear that this warming trend is largely attributable to human activity, especially the burning of fossil fuels (which provide roughly 80% of the world's energy) and the associated release of carbon dioxide and other greenhouse gases into the atmosphere. There is also a consensus that this warming, along with other climatic changes, will have earlier and more pronounced impacts in the polar regions of the Earth than in almost any other region.

The effects of climate change in the Arctic will be complex and far-reaching, affecting an enormous range of human activities, plant and animal species, and Earth systems. These effects will also extend well beyond the current century. Because greenhouse gases remain in the atmosphere for centuries after they are emitted, humans will be dealing with the consequences of climate change for generations. But it is not merely a future prediction; in fact, the impacts of climate change are already being felt all around the Arctic. Some of the current trends and expected future effects discussed in the 2004 Arctic Climate Impact Assessment (ACIA)[3] are:

- The melting of Arctic snows and ice, which decreases the reflectivity of the Earth's surface and contributes to warming, and also causes rising sea levels
- The decline of various animal species that depend on sea ice in the Arctic Ocean (such as polar bears and seals) or on stable frozen tundra (such as caribou)
- The thawing of permafrost, which endangers human infrastructure like buildings and roads, and will likely release large amounts of methane trapped in the soil that will exacerbate warming
- The increasing vulnerability of coastal communities to erosion, as a result of sea level rise and more powerful storms
- The opening of new trans-Arctic shipping routes through the Northern Sea Route and the Northwest Passage, and increasing access to undiscovered oil and gas resources
- Serious challenges to the survival of many indigenous cultures, in the face of diminishing traditional food resources and a more unpredictable environment

[1] Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2007: Synthesis Report Summary for Policymakers*. http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf.
[2] IPCC, *Climate Change 2007.*
[3] ACIA, *Impacts of a Warming Arctic: Arctic Climate Impact Assessment.* Cambridge University Press, 2004. http://www.amap.no/acia/

It is vital that the future plans of the United States and other Arctic nations address the difficulties and opportunities presented by Arctic climate change—not only because of their stake in the Arctic region, but because climate change in the Arctic has important consequences for the rest of the world. Melting snow and ice, thawing permafrost, new shipping routes and hydrocarbon sources, along with a host of other effects, will reverberate globally.

According to the Intergovernmental Panel on Climate Change, human efforts to mitigate climate change can make a significant difference in the rate and degree of warming, and thus minimize the accompanying negative impacts of climate change.[4] The U.S. Arctic Research Commission (USARC) requested this paper in order to begin a discussion on the potential contributions that the U.S. Arctic Research Program may make to the nation's efforts to mitigate climate change. The U.S. Arctic Research Program has already established an interagency effort, the Study of Environmental Arctic Change (SEARCH), to track climate change – and that effort is being bolstered with the creation of an Arctic Observing Network. The nation has another Arctic research goal – infrastructure research – to provide adaptation tools. Some of the new research directions discussed in this paper would fit well within those two goals. USARC may decide to include some of the new research directions included here in the 2009 Goals Report, and the Interagency Arctic Research Policy Committee (IARPC), which carries out the nation's Arctic Research Program, may decide to pursue this research.

The nation's current climate change mitigation program, which is organized under the Climate Change Science Program (CCSP) and the Climate Change Technology Program (CCTP), was developed by the Committee on Environment and Natural Resources of the National Science and Technology Council (NSTC). Though the mitigation program currently in effect through CCSP and CCTP is a solid beginning, it was not designed with the issues and concerns of the Arctic solely in mind. This paper could be used to enhance the current mitigation program and eventually develop a program that makes full use of the Arctic both as a research venue and as a testbed for mitigation technologies.

This paper identifies six areas in which the Arctic may play a major role in U.S. mitigation strategy:

1) **monitoring of climatic shifts, to support modeling of global effects and accounting for global sequestration strategies**
2) **understanding and protection of natural carbon sinks**

[4] IPCC, *Climate Change 2007.*

3) **modification of point-source energy production methods**

4) **energy conservation and efficiency measures**

5) **methane hydrate research and carbon capture and storage technology**

6) **Geoengineering schemes which take advantage of natural features in the North**

Given that Alaska consumes more energy per capita (and therefore causes more per capita emissions) than any other state, [5] federal investments in mitigation strategies in Alaska may produce more significant carbon emission reductions than equivalent investments elsewhere. Alaska Governor Sarah Palin's recent announcement that the state will set aside $250 million for renewable energy funding, along with her establishment of a Climate Change Sub-Cabinet and appointment of a state-wide Energy Coordinator, indicates that Alaska is ready to move on climate change issues and that federal agencies may benefit from partnering with the state. In addition, a large number of organizations in Alaska are working toward a more sustainable future in various ways, many of which would be valuable partners as well. Many of them are mentioned throughout this report.

Outline of the Report

This paper begins by explaining what is currently known about the Arctic carbon cycle and the processes of Arctic warming. It then describes a rubric that was used to evaluate various mitigation strategies that have the potential to take advantage of unique conditions in the Arctic. Evaluations of the particular strategies follow after that.

- In the first evaluation section, on monitoring, the global need for more widespread and better-integrated Arctic monitoring systems is discussed, and goals for further research are laid out.

- The second section—on natural carbon sinks—reviews the current scientific knowledge of boreal forests, peatlands, permafrost, and their roles in the Arctic carbon cycle. It also considers how management of these sinks could aid in expanding carbon sequestration.

- The third section covers non-fossil fuel energy sources available in the Arctic, or to Arctic residents seeking to stabilize costs and reduce greenhouse gas output: geothermal power,

[5] DOE Annual Energy Report 2007.

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hydroelectric power, wind power, solar power, wave and tidal and osmotic power, biomass power, power from hydrogen and fuel cells, and nuclear power.

- The fourth section examines various measures that can be applied to aid energy conservation and to increase energy efficiency. These include: personal- and community-level responses to climate change, "smart grid" technologies, combined heat and power systems, and better building design and building practices.

- The fifth section discusses carbon capture and storage and the extraction of methane hydrates, both of which have the potential to mitigate human carbon emissions while taking advantage of the existing infrastructure and technology of the oil and gas industry.

- Finally, the sixth section describes three different theoretical "geoengineering" schemes—solar shielding, expulsion of particulates, and iron fertilization. Research on these schemes might be able to present solutions the Arctic region can provide to the rest of the world in an attempt to prevent catastrophic global warming.

The Conclusion discusses the importance of responding effectively to climate change, and the critical role that the Arctic can play in the national mitigation strategy. The final section recommends future Arctic research projects.

This paper does not address the current policy debate facing a world which has stated its intent to reduce greenhouse gases to reverse climate change trends. The choice of incentives to cut carbon emissions efficiently –such as subsidized technology, carbon taxes, or a so-called cap-and-trade program for carbon emissions – is beyond the scope of this paper and of the Commission's mandate.

To be clear, all of the mitigation schemes discussed in this paper deal primarily with means to reduce or sequester carbon generated in commercial energy production; carbon emissions from industrial agriculture, transportation or domestic use are not accounted for in many of the scenarios covered. Some mitigation schemes, however, deal with carbon generally. For a complete (though not Arctic-specific) discussion of carbon mitigation technologies, see Field and Raupach, eds., *The Global Carbon Cycle.*[6]

[6] Christopher Field and Michael R. Raupach, eds. *The Global Carbon Cycle.* Scientific Committee on Problems of the Environment, 2004, p108.

Adaptation research,[7] including infrastructure research, is already included in the nation's Arctic Research Plan, and will not be covered here.

Another clarification: "carbon", as used in this paper, refers not merely to carbon in its elemental form, but to any number of (generally gaseous) carbon compounds. Primary "carbons" discussed here are carbon dioxide (CO_2) and methane (CH_4). Both of these are greenhouse gases, but methane's global warming potential (GWP) is far higher than that of CO_2.[8]

[7] For a discussion of the philosophy of adaptive response to climate change, see the Pew Center on Global Climate Change's document "Coping with Global Climate Change: the role of adaptation in the United States" (Easterling, Hurd, and Smith, June 2004).
[8] Reay, Dave. The Encyclopedia of Earth, 2007: www.eoearth.org/article/Greenhouse_gas.

The Carbon Cycle in the Arctic[9]

The Arctic carbon cycle consists of two main components: the terrestrial and the aquatic. The terrestrial carbon cycle works through several processes. Plants take in carbon through photosynthesis; with the death and decay of plants and animals (or by their respiration), carbon is released back to the atmosphere. Geographic weathering may also reintroduce carbon into the cycle through the oceans. The combustion of fossil fuels for transportation and energy and industrial agriculture, the production of cement, and volcanic eruptions all introduce carbon into the atmosphere.

The aquatic carbon cycle, which is not isolated by any means from the terrestrial carbon cycle, has within it two distinct cycling systems. Carbon enters the ocean through both a "solubility pump" and a "biological pump". The term "solubility pump" describes the mechanism by which atmospheric carbon dissolves in ocean water. The cooling of water near the poles increases the amount of carbon-based gases that can be dissolved in it. As the water cools, it becomes denser and sinks, producing a circulation through which carbon is carried down into the deep ocean. The "biological pump" occurs as sinking particulates such as exoskeletons (made of calcium carbonate) and fecal matter deposit carbon in the deep ocean. The same upwelling that drives the solubility pump cycles this organic carbon through the ocean.

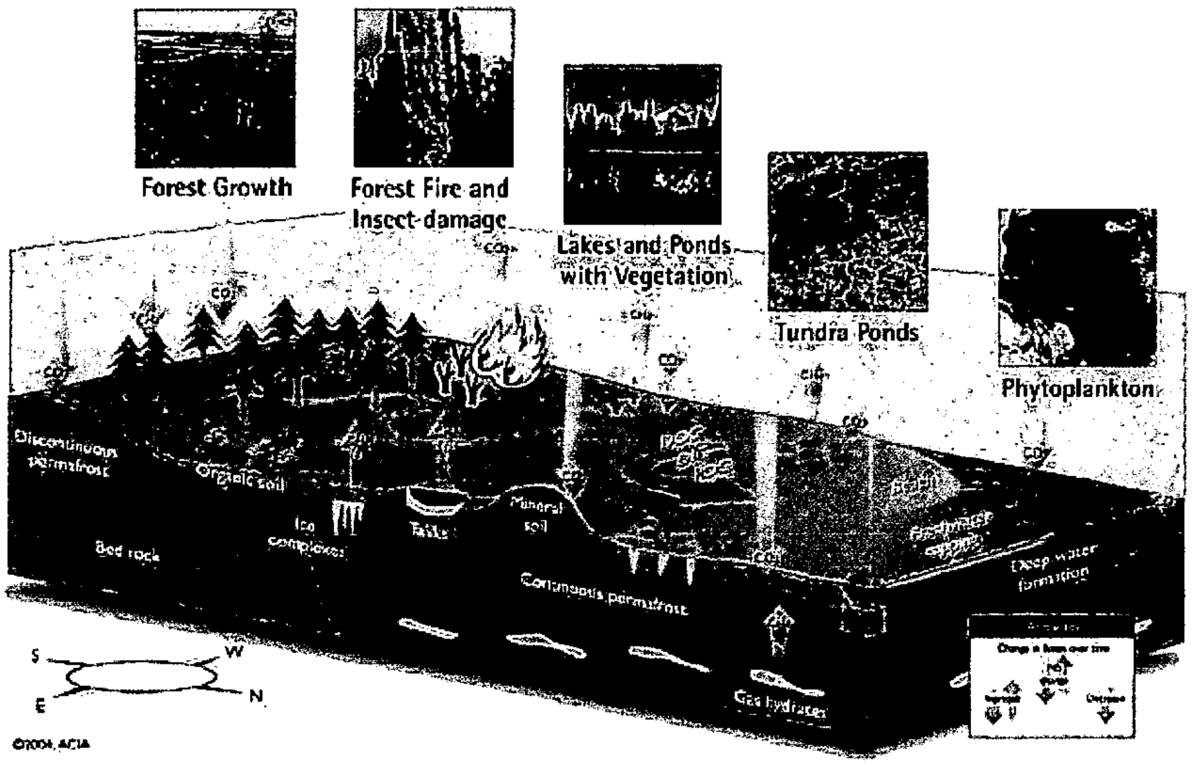
Both the geology and ecology of the Arctic play a role in the region's carbon cycle. Much of the Arctic lies in zones of high seismic and volcanic activity, which are often associated with high rates of natural geological CO_2 emissions. Permafrost and peat, distinctive Arctic soils, act as a storage place for carbon, primarily in the form of methane. Boreal forests, or taiga, also sequester large amounts of carbon.

Though many scientists have investigated the process, the mechanics of the Arctic carbon cycle remain largely a mystery, and many believe that "unlocking" the carbon cycle is the most important step in advancing future mitigation science. A number of further studies on the cycle are currently underway. For example, the American Geophysical Union (AGU), inspired by the completed Arctic Climate Impact Assessment, is now conducting an Arctic Carbon Cycle Assessment.[10] The National Science Foundation-led, USARC-inspired SEARCH program maintains monitoring stations throughout the Arctic, most notably at Toolik Lake and Barrow in Alaska, which continuously gather data on the cycle. The

[9] Please see Figure 1, on page 4 of this report.
[10] Heyes et al, "Supplemental Material to 'A Scientific Synthesis and Assessment of the Arctic Carbon Cycle'", 2007. http://www.agu.org/eos_elec/2007/26-270.html

University of Montana is also engaged in its own assessment of the Northern Carbon Cycle (through freeze-thaw periods) and a monitoring program.[11]

The Arctic Carbon Cycle



(Image courtesy of ACIA)

[11] Kimball, J.S., Northern Carbon Cycle project. www.umt.edu/flbs/Research/NCC.htm

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A Rubric to Evaluate the Possibilities

The technologies and measures discussed in this paper run the gamut from passive monitoring to active management, and from relatively cheap to very expensive. A rubric follows, through which the potential benefit of each option may be ranked. However, in any carbon management plan in the Arctic, as in the globe, it is likely that one solution is not sufficient—mitigation strategies will likely be assembled into a comprehensive "portfolio" for addressing climate change.[12] Each mitigation strategy shall be evaluated under the following criteria, with attention to economic efficiency and feasibility. A few of the mitigation strategies included merit a brief discussion, but not a full analysis using these categories, and those sections will be shorter. For some other strategies, certain portions of the rubric are not applicable—for instance, most renewable energy sources have essentially no feedback problems—and will not be discussed.

Further Research & Development Needs (R&D)- Some of these technologies, such as carbon capture and storage and wind power, are well-established and tested; others, such as geoengineering, remain purely theoretical. This section of the rubric projects a future course for the development of each mitigation strategy.

Infrastructure Needs- As with the research and development section of the rubric, this portion describes what infrastructure is already in place and what needs further development for various technologies. For example, monitoring is an area in which further infrastructure must be established, because today's in-situ measurement stations are sparsely located.

Implementation Costs- This section serves as a rough estimate, before accounting for feedback, of the cost of future R&D, infrastructure development and deployment of the strategy. Implementation "costs" are derived from theory, from practice, and sometimes from government organizations' budget information. Explanations of why the costs might be at such levels are included.

Geopolitical or Cultural Considerations- Because the Arctic is part of the global commons, with territory owned by many—or all—nations, deploying effective carbon mitigation schemes may require international cooperation. This portion of the rubric will speak to the role of cooperative mechanisms, and in some cases consider impact on Native communities.

[12] Field and Raupach.

Feedback Issues- Climate change begets further climate change. The greenhouse effect works as a feedback cycle and the world is now witnessing a snowballing of feedback cycles in the Arctic. Even if a technology appears to address a surplus in carbon, there is a chance that the technology could somehow add carbon back to an earth system or increase warming in other ways. Thus, some strategies may not be as effective as projected. For this reason, feedback cycles affect the cost and timescale of different mitigation strategies.

Feedback has four subsets: albedo, GHG uptake or emissions, GHG emissions from methane hydrates, and increased freshwater fluxes which could affect thermohaline circulations in the world's oceans.[13] All carbon mitigation schemes will be examined through these four lenses, on which various scientists as well as the authors of the ACIA have agreed. Albedo, the only feedback mechanism not directly involving carbon, is the ratio of reflected to incident light; an albedo of 1 means that all light is reflected, while an albedo of 0 means that all light is absorbed. Greenhouse gas uptake or emission describes whether an entity acts as a source or sink of those gases, and GHGs from methane hydrates are included because of the hydrates' propensity for escape and the relative global warming potential (GWP) of CO_2 and CH_4. Increased freshwater fluxes result from melting ice and from altered ocean oscillations. All of these feedbacks exacerbate each other, since warming from gases may encourage release of more gases, for example.

Timescale- This portion of the rubric describes how quickly various mitigation schemes might be deployed. Of course, this can shift depending on pressures or initiatives from interest groups.

Federal Programs- This section will detail the current federal research programs and initiatives that are relevant to each mitigation strategy. These will often fall under the umbrella of either the CCSP, which coordinates federal research programs in a number of departments and agencies that are related to understanding the processes and impacts of climate change, or the CCTP, which coordinates federal research programs related to development of a host of climate change mitigation technologies—ranging from nuclear fission to solar panels to electricity grid upgrades. However, there are other departments and agencies that have established relevant programs, and these will be included as well. In the first two sections, on monitoring and carbon sinks, and in the section on methane hydrates and carbon capture and storage, this segment of the rubric will be integrated into the other segments.

[13] Callghan et al, "Climate Change and UV-B Impacts on Arctic Tundra and Polar Desert Ecosystems", Key Findings and Extended Summaries, 2004. http://www.bioone.org/perlserv/?request=get-document&issn=0044-7447&volume=033&issue=07&page=0386. Also, see ACIA, p. 315.

Short- and Long-term Benefits- These sections illustrate how effective a technology might be on a long or short timescale. They help weigh the costs and the feedback mechanisms when evaluating a technology. Some carbon "solutions," such as stratospheric spreading of particulates, are only effective in the short-term, while others, such as boreal forest and permafrost sinks, are likely to sequester carbon for long periods of time.

Mitigation Schemes the Arctic Research Program May Consider

A matrix is presented here that summarizes the results of applying the rubric described above to each of the possible mitigation strategies. A detailed discussion of each mitigation strategy then follows, which supports the results included in the matrix.

Mitigation Scheme	R&D Needs	Infrastructure Needs	Implemen-tation Costs	Geopolitical or Cultural Considerations	Feedback Issues	Timescale	Federal Progams	Short- and Long-Term Benefits
Enhanced Monitoring	In-situ and remote sensing monitoring systems	Integrated monitor-ing systems—e.g. the AON	Propor-tional to the extent of the program	Will require inter-national collabor-ation	N/A	Techno-logy available today, but will take time to imple-ment	Partner-ships: OCO, GCOS, GEOSS; CCSP	Increased carbon emissions accountability; better understanding of climate changes
Boreal Forests	Understand-ing of nutrient and feedback cycles; fire manage-ment strategies	Systems for monitor-ing of forest cycles and fire suppre-ssion	Propor-tional to the extent of monitor-ing and fire suppre-ssion efforts	May cause inter-national impacts, and require inter-national collabor-ation	Complex, and not fully understood; fires may either help or hinder carbon sequestra-tion	Forest research and manage-ment is ongoing	BLM Alaska Fire Service; CCSP	Forest management may enhance this important carbon sink in the long term
Peatlands and Permafrost	Understand-ing of feedback cycles; marginal potential of peat as a fuel	Monitor-ing systems and strength-ening of civil infrastruc-ture	Propor-tional to the extent of monitor-ing and infrastruc-ture strength-ening	Soils are important to local ecosys-tems and local peoples	Warming may cause large GHG emissions	Ongoing research and develop-ment of infrastru c-ture	DOI's perma-frost monitor-ing network in northern AK; CCSP	Management may enhance this carbon sink in the long term
Geothermal Power	Exploration and drilling technology; EGS systems; transport	Infrastruc-ture for drilling, explora-tion and transport	High start-up costs and low costs thereafter	Reduces depen-dence on imported fossil fuels	Negligible emissions; may actually reduce atmospheric carbon	Currentl y available ; needs funding	DOE prog-rams, e.g. GeoPow ering Amer-ica; CCTP; federal PTC	Local, reliable energy source; reduces carbon emissions

Hydroelectric Power	Studies of micro-hydro feasibility in rural Arctic; cold climate issues	Transmission capacity	High initial costs	Clean, domestic energy source	No carbon emissions, but can have other significant environmental impacts	Currently available; possible long lead time	DOE EERE's Wind and Hydropower Technologies Program	Local, reliable, renewable source of base-load power
Wind Power	Energy storage; wind-diesel hybrid systems; coupling with hydrogen production	Wind-diesel hybrid systems; local wind energy infrastructure	High initial costs; in rural Arctic, high shipping and other costs	Can provide starting point for rural community energy plans	No carbon emissions, but possible minor environmental impacts	Currently available and growing quickly	DOE EERE's Wind and Hydropower Technologies Program; CCTP; federal PTC	Renewable energy source; only hampered by intermittency issues
Solar Power	Solar power coupled with other renewable energy sources	N/A	Not feasible on a large scale in the Arctic	N/A	None	May become more cost-effective in the future	Various DOE programs; CCTP; federal PTC	May provide reliable power when coupled with other renewable sources
Wave, Tidal and Osmotic Power	Further demonstration of wave and tidal technology; feasibility study of osmotic power	Energy transport for wave power; greater funding and production incentives	High initial costs	N/A	No emissions; possible minor environmental impacts	May become competetive within a decade	Small amount of DOE R&D funding	Denser and more predictable energy source than wind or solar
Biomass Power	Feasibility studies of various biomass options; demonstration projects	Local biodiesel capacity; landfill gas extraction; CHP systems	High initial costs in some cases	N/A	Small emissions relative to fossil fuels	Currently available; ongoing development	Various DOE and EPA programs; CCTP; federal PTC	Reduces carbon emissions and extracts energy from waste

Hydrogen and Fuel Cell Technology	Development of nearly all aspects of the technology; e.g. wind-hydrogen demonstration project	Large-scale replacement of energy infrastructure	Enormous costs for both development and implementation of "hydrogen economy"	Requires significant international cooperation (e.g. IPHE)	Depends on how hydrogen is produced	No significant impact for a decade or more	DOE Hydrogen, Fuel Cells and Infrastructure Technologies Program; CCTP	Clean fuel source; possible clean energy storage and transport medium
Nuclear Power	New reactor types; efficiency improvements	Nuclear waste disposal	Very high initial costs	Citizen opposition and potential for nuclear proliferation	No carbon emissions; environmental concerns because of nuclear waste	Currently available; can take ten years to build a new plant	Various DOE programs; CCTP	Widely accepted non-fossil energy source without carbon emissions
Personal Conservation and Community Planning	Research on current awareness and ways to conserve, and on better community planning practices	Education campaigns; central information source; community plans	Very few costs; costs are usually repaid in energy savings	Cooperate with other Arctic nations in developing best practices	Reduces unnecessary energy use and emissions	Immediately available; should be current and ongoing process	Efficiency programs, e.g. Energy STAR	Cheapest way to reduce energy costs and carbon emissions
"Smart Grid" Technology	Feasibility studies; better utility management systems for integrating "distributed generation"	Deployment of technologies, coinciding with upgrade of grids themselves	Depends on the scale of the technology, usually high initial cost	N/A	Increases efficiency	Currently available, or will be available soon	DOE programs; CCTP	Increases efficiency and reduces emissions; increases consumer awareness of energy use
Combined Heat and Power Systems	Feasibility studies; demonstration projects, especially of diesel heat recovery systems	Fuel sources; integration with building; smart grid technology	High initial costs	N/A	Reduces energy use and emissions per unit of fuel used	Currently available	EPA CHP Partnership; CCTP; federal PTC (biomass)	Increases energy efficiency and flexibility of the grid

Building Design and Practices	Development of better design, materials and practices for Arctic buildings; net-zero-energy systems	Implementation of better practices, including education	May be high initial costs	Cooperate with other Arctic nations in developing best practices	Increases efficiency	Currently available; net-zero-energy buildings still expensive	Various DOE programs; CCTP	Increases energy efficiency and creates jobs; reduces long-term emissions
Methane Hydrates	Feasibility studies of stability of methane hydrates and possibility as a fuel source	Infrastructure strengthening	Large costs for at-sea operations	Possible conflicts over ownership of undersea resources	Relatively low carbon emissions compared to other fossil fuels; danger of "blowouts"	Could have significant impact within a decade	DOE; CCTP	Large fossil energy source with low relative emissions
Carbon Capture and Storage Technology	Further demonstrations of CCS technology; research on clathrates, monitoring	Coupling CCS with existing production wells; monitoring systems	Too expensive to implement widely without incentives	Can cause disputes where storage sites cross national boundaries	Reduces emissions directly; concerns about carbon escaping from underground and citizen opposition	Currently available, though expensive; will be motivated by regulation	DOE; CCTP	Reduces carbon footprint of fossil energy production; allows time for renewable energy development
Geoengineering (Solar Shielding and Expulsion of Particulates)	Effects on climate; possible feedback cycles; feasibility studies	Enormous but unclear	Enormous	Very complex negotiations necessary; uneven distribution of gains and losses	Potential for unintentional effects on climate	Not known precisely, perhaps decades	N/A	May avert catastrophic warming in the short term

1) Enhanced Monitoring

Monitoring of carbon levels in the ecosystem is gaining importance as climate change becomes more critical—not only as an indicator of the scope of the planet's warming, but also as a way of increasing emissions accountability under initiatives like the Kyoto Protocol. Especially in the Arctic, the site of the most extreme and rapid climate change, monitoring can help determine sources of greenhouse gases in the atmosphere, in order to guide a global course of action for combating harmful warming. Monitoring is a diverse branch of essential research for carbon mitigation, and must collect data on: 1) atmospheric carbon, 2) soil carbon (which often involves seismic analysis of permafrost and seabed hydrate formations), 3) flux through surface vegetation, and 4) point-source emissions. In addition, it is essential that these data are gathered through an integrated monitoring system in order to generate a comprehensive picture of the Arctic carbon cycle. Because of the influence of other elements on carbon cycling, as well, monitoring of several different nutrient cycles can also give a sense of the extent of the carbon cycle. Understanding and assigning numeric value to this essential yet enigmatic element is a challenge, but one that must be overcome in any effort to curb climate change.

R&D- Carbon monitoring in the Arctic needs to reach an appropriate balance between in-situ recording and remote-sensing, for several reasons. Extrapolation of *in-situ* data points is often inaccurate, while satellite imaging is not detailed enough. Each involves a trade-off: *in-situ* data can give a sense of the soil composition—of extreme importance in Arctic ecosystems especially—while remote-sensing can measure factors like tree cover. Given carbon's role at both the micro- and macro-scale, an integrated monitoring system is an essential aim for further research. USARC has set up a workgroup to define research which will help to better understand the scaling issues.

Infrastructure Needs- The needs for Arctic monitoring infrastructure are huge—and include the development of detailed data collection over a wide area—though they are gradually being addressed through the development of the Arctic Observing Network (AON).[14] Of key importance to the AON is the integration of various international monitoring systems to provide one complete picture of the Arctic environment. Besides the AON, NASA plans to launch the Orbiting Carbon Observatory (OCO) in 2008, which will provide the first-ever data-gathering on atmospheric carbon from space. The U.S. has joined the international Global Climate Observing System (GCOS), which will focus on the Arctic during the International Polar Year (IPY),[15] and also the Global Earth Observing System of Systems (GEOSS)

[14] Information about the AON's needs and goals can be found at http://dels.nas.edu/prb/aon.
[15] *The U.S.Climate Change Science Program for FY2008*, p. 27: http://www.usgcrp.gov/usgcrp/Library/ocp2008/default.htm.

effort, a partnership between nearly 60 countries for coordinating Earth observations which promises to be an important framework for international cooperation on monitoring and management of the environment.[16]

Implementation Costs- The cost of an Arctic carbon monitoring system can be as open ended as the requirements that are established for the system itself. Current IPY awards for AON development total approximately 37 million dollars from FY06 through FY09.[17] While this system will be immensely helpful to future scientific research, many scientists caution that the cost of demonstrating carbon level changes often can exceed the value of the reduction in emissions.[18] Accountability and economy, therefore, drive one another. As nations determine the "costs" of carbon through regulation, carbon tax or market based cap-and-trade schemes, the value of monitoring initiatives will become more apparent.

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[16] From the Group on Earth Observations (GEO) website: www.earthobservations.org/.
[17] Martin Jeffries presentation at National Ice Center and USARC Conference, "On the Maritime Implications of an Ice-Diminished Arctic," July 2007.
[18] Field and Raupach, p. 487.

2) Fostering Carbon Sinks

The natural carbon sinks of the circumpolar regions are among the largest in the world. Approximately 13% of the earth's carbon lies in the boreal forest soils, with an additional 14% in tundra soils. This 27% of the Earth's terrestrial carbon is stored within 13%-14% of the Earth's total land area.[19] This large amount of sequestered carbon is cause for concern if its release is part of a warming feedback cycle.

The complexity of Arctic ecosystems presents an obstacle to prescribed mitigation, because the myriad interactions between various molecules and organisms have yet to be fully understood. A scheme aimed only at one natural sink, while it may be helpful, will also be fundamentally insufficient, due to the fact that a sink is part of a larger carbon cycle. Any carbon mitigation scheme involving natural sinks must necessarily examine the other nutrients or microbes involved in the cycle, since without an understanding of these interactions human efforts could potentially impede, rather than facilitate, the functioning of the sinks.

While the Kyoto Protocol stipulates that natural sinks must be preserved and encourages their management to enhance sequestration,[20] direct management of carbon fluxes on Alaska's vast tracts of wild land is probably not feasible. Therefore, research should focus on understanding—and monitoring—nutrient cycling in Arctic tundra and taiga ecosystems. Understanding natural sinks and implementing monitoring systems will help to protect them and also increase accountability for damage to them. Various CCSP-coordinated research activities address the need for understanding Northern forests: the Yukon River Basin research initiative (a comprehensive study of air, water, soil, forests and adjacent ocean in the Basin), the National Land Cover Database (a complete land cover map at 30 meter resolution of the whole U.S., the Alaska section of which was just finished), and advanced carbon modeling of the both the terrestrial and aquatic carbon cycles.[21]

While much research and many resources have been dedicated to managing cropland to work as a carbon sink, this science is not included in this report because it is not yet very applicable to Northern regions, though it may become so with climate change. The extent of, and direction of, agricultural shifts due to climate change are relatively unpredictable: changes in moisture and temperature must balance one another, and an increase in temperature without one in precipitation could threaten Alaskan farming,

[19] J.M. Kimble, ed. "The Potential of U.S. Forest Soils to Sequester Carbon and Mitigate the Greenhouse Effect" (2003) Ch. 16, p. 3: www.environetbase.com/books/1040/l1583_fm.pdf
[20] Kyoto Protocol website: http://untreaty.un.org/English/notpubl/kyoto-en.htm.
[21] *The U.S. Climate Change Science Program for FY2008*, pp. 51-52: http://www.usgcrp.gov/usgcrp/Library/ocp2008/default.htm.

while an increase in both could bolster it.[22] It is therefore worth paying attention to cropland management techniques, and worth realizing that they may eventually become relevant in northern latitudes. Techniques for managing grazing land could become appropriate as well, particularly in the northern regions in which reindeer herding is a main source of subsistence, such as the Lapland areas of Fennoscandia.

a) Boreal Forests

The Northern boreal forest, or taiga, is a hugely important carbon storage system, which constantly vies for the title of largest terrestrial carbon sink.[23] Unlike tropical forests, which absorb a greater amount of carbon but hold it for a lesser time, boreal forests hold the carbon they absorb for many years.[24] While much of the ability of the taiga to act as a sink is due to the organic material of its soils, the trees play an important role through respiration and photosynthesis. Current research into the nature of the boreal forest is more diagnostic than anything else. Future research should focus on the interaction between various nutrients and microbes and the carbon cycle, and also on the study of management techniques—especially fire management.

Management of boreal forests requires understanding not only of nutrient cycles, but of stand disturbance cycles. If natural succession or disturbance cycles occur such that carbon storage isn't maximized, then management of the stand can tip cycling in that direction. As disturbance cycles increase (as is the case with frequent fire incidence), then management geared towards suppressing disturbance is effective for carbon storage as well.[25] However, in unmanaged lands with relatively stable disturbance cycles, there is little need to maximize sequestration with management, nor will any human effort do so efficiently, especially with a hazy understanding of how the soil and its nutrients are effected by disturbance cycles.

Fire management is discussed here because it is a practice at which Alaska is old hand. It is an exercise in balancing: forests tend to sequester more carbon as they get older, but also have a tendency to burn and to emit all of that carbon. Managing burns at the correct stage of forest succession can help optimize the amount of carbon sequestered in a forest. Because coniferous trees require fire to release their seeds, total

[22] ACIA, p. 808.
[23] Stephens et al, 2007 "Weak Northern and Strong Tropical Land Carbon Uptake from Vertical Profiles of Atmospheric CO2": www.sciencemag.org/cgi/reprint/316/5832/1732.pdf
[24] Davidson et al, 2000. "Soil Warming and Organic Carbon Content" Nature 408: 789-90
[25] Can. J. For. Res. Vol. 27, 1997 Price et al

fire suppression is not an option for the taiga. But wise fire management can maximize carbon sequestration while promoting the health of the forest.

R&D/Infrastructure Needs- Research on fire management continues to grow, after the 1999 Frostfire Prescribed Burn in which the federal Bureau of Land Management (BLM) Alaska Fire Service set a boreal plot on fire in an effort to study every aspect of taiga burns.[26] While research must continue to develop an understanding of how fire affects nutrient cycling, one of the most important needs for R&D—and indeed, infrastructure—is monitoring. Monitoring need not be constant—in fact, meteorological satellites may be appropriate to detect fires. But closer monitoring of fires could provide insight into the carbon cycle. The Canadian Forest Service releases an annual Fire Research Science Report,[27] and much current boreal forest research centers on the effects of fire on the carbon budget.

Implementation Costs- Monitoring is a large implementation cost for a fire management system. In addition, fire suppression and burn costs balance one another: if boreal forest is allowed to burn, suppression costs go down; if it is not, suppression costs rise.[28] Carbon storage, obviously, increases with suppression; in other words, the cost of suppression is essentially the cost of sequestration.

Geopolitical and Cultural Considerations- Fires never seem to be popular, especially if people have built their homes on the land near burn sites. Ash from fires can also carry in the atmosphere and deposit in other countries; large-scale prescribed burns might require international collaboration.

Feedbacks- The issue of forest albedo is a tricky system of balances: even if there is snow cover on vegetation, reflections within the canopy scatter the radiation and do not necessarily reflect it back.[29] Fire releases GHGs and affects the albedo of a landscape in various ways. It spreads ash, but also allows snow cover and reflectivity. The feedbacks associated with forest fires are not clearly positive or negative; they are a balance between the release of GHGs and the increased albedo. Therefore, future research on taiga carbon sequestration must center on understanding the relationship between feedback cycles.

[26] USDA Forest Service Frostfire Burn website: http://www.fs.fed.us/pnw/fera/research/targeted/frostfire/index.shtml.
[27] Canadian Forest Service Fire Research website: http://fire.cfs.nrcan.gc.ca/research/index_e.php.
[28] Emina Krcmar and G. Cornelis van Kooten, 2005. "Boreal Forest Carbon Sequestration Strategies: A Case Study of the Little Red River Cree First Nation Land Tenures": http://www.blackwell-synergy.com/doi/pdf/10.1111/j.1744-7976.2005.00022.x
[29] Betts, 2000. "Offset of the potential carbon sink from boreal forestation by decreases in surface albedo", *Nature* 408:188.

Timescale- Fire management has been a longstanding practice; it is currently being refined, and it should continue to be studied well into the future.

Short- and Long-term Benefits- The short-term benefits of fire suppression are the immediate reductions in carbon emissions; however, because of the uncertainty in the fire-albedo feedback cycles and new vs. old growth sequestration capacity, ultimately fires could prove a boon to carbon storage. Thus, the long-term benefits of fire suppression hinge on further research into the appropriate balance between old- and new-growth forest sequestration.

b) Peatlands and Permafrost

Two soil formations unique to the Arctic are permafrost and peat. Permafrost is a layer of permanently frozen soil, and peatlands are acidic accumulations of decaying organic matter on the surface of the soil horizon. Peatlands, by definition, are wetlands, and in fact worldwide compose half of the world's wetlands.[30] Both permafrost and peatlands are important to carbon mitigation because they sequester 98% of the carbon in Arctic ecosystems[31] (and worldwide, peatlands account for 30% of the world's soil carbon[32]).

When permafrost thaws, it not only forms unstable thermokarsts, or lakes, which can damage civil infrastructure, but it also emits large amounts of methane. Some of this methane is stored under the permafrost in clathrates, the frozen cages that often contain methane hydrates (discussed further below). When peatlands are disturbed, they too act as carbon emitters, and if drained widespread desertification can result. Both soils take long periods of time to form, and mitigation of disturbed soil is barely feasible. Neither soil is a carbon sink that can be manipulated to solve many GHG problems, so research should focus on the effects of warming and understanding the ecosystems associated with these soils.

R&D- Arctic soils research should emphasize an understanding of their complex nutrient cycles, of what is causing their destruction, and an examination of how to reconcile land use with soil health. Peatlands are also a potential fuel source, with fewer non-carbon GHG emissions than traditional fossil fuels, though whether they classify as fossil fuel or biomass is currently a topic of debate.[33] Study could focus, , both on peat's fuel potential, as well as on investigating the effects of warming and what might be done to

[30] Global Peatlands Initiative website: www.globalpeatlands.net.
[31] http://web.mit.edu/12.000/www/m2007/teams/finalwebsite/environment/phyenv_nutrient.html
[32] "Carbon Balance of Peatlands", USGS (2000): http://www.aswm.org/science/carbon/quebec/sym43.html
[33] International Peat Society website: www.peatsociety.org.

save the soils. Currently, major research through the Global Peatlands Initiative concentrates on world peatlands about which little is known, which should increase knowledge of peatlands in general, but unfortunately the only Arctic peatlands included in that survey are those in Siberia.[34]

Infrastructure Needs- Of concern with melting permafrost is its inability to physically support infrastructure. Even the processes of building can sometimes harm permafrost[35] and increase thermokarst formation. The U.S. Department of the Interior is currently developing a long-term permafrost monitoring network in northern Alaska, which will contribute to the Global Terrestrial Network for Permafrost and the Global Climate Observing System; initial data analysis has suggested that permafrost there has undergone significant warming in the last twenty-five years.[36] With regard to peat, if it becomes a viable contender as a fuel source, peat-specific power plants must be constructed. Finland has many, supplying much of the country's fuel demand with the peat covering 25% of its surface area. However, peat as a large-scale energy enterprise has not been developed anywhere in the world. The amount of peat in the Arctic is large, but the length of time it takes to form is long enough, perhaps, to rank peat as nonrenewable.

Implementation Costs- Implementation costs fall into two categories: infrastructure strengthening and monitoring. Both categories are relatively expensive. The cost of peat-fired power plants is not considered here because it is feasible only at a very local level or in Finland.

Geopolitical and Cultural Considerations- Of chief importance is the balance between different land-use interests and soil conservation. Development of peatlands in particular—which occurs extensively all over the world—is irreversible, yet preserving them leaves the land vulnerable to future development.[37] Soils are important to the preservation of cultures and ecosystems: peat is the traditional fuel source of many small Northern communities, so its continued use is in their interest. Peatlands also house many unique plant and animal species, and to burn a peatland is to destroy a viable ecosystem. Permafrost, as well, supports much of the Arctic ecosystem, and its degradation can disrupt traditional hunts and subsistence gathering.

[34] Global Peatlands Initiative website.
[35] USARC Report on Permafrost and Infrastructure, December 2003.
[36] *The U.S.Climate Change Science Program for FY2008*, p. 26: http://www.usgcrp.gov/usgcrp/Library/ocp2008/default.htm.
[37] International Peat Society website

Feedback Issues and Timescale- While peatlands and permafrost can only sequester seemingly small amounts of carbon at a timescale comparable to some other soils, the amount of time for which the carbon is stored is far greater.[38] Because of recent feedback, however, the carbon being released from some Northern soils is far younger than expected, indicating rapid and positive feedback.[39] The conversion of Northern soils from huge carbon sinks to huge methane sources is a frightening prospect and a likely contributor to rapid future warming.

Short- and Long-Term Benefits- The short-term benefits of protecting Arctic soils are infrastructure integrity, species diversity, and the ecological benefits accrued from wetlands (in the case of peat). Because soil carbon sequestration is a long-term process, its benefits are all long-term.

[38] Davidson et al.
[39] "Arctic Carbon a Potential Wild Card in Climate Change Scenarios": http://www.sciencedaily.com/releases/2004/04/040420213929.htm

3) Point-Source Energy Production

For many reasons, the Arctic may provide a testbed for implementation of methods of point-source energy production not based on fossil fuels. In some cases, the Arctic may be a choice due to availability of resources. In other cases, the Arctic region's generally high energy costs may encourage development and implementation of new technologies.

Much of the information in this section comes from presentations at the Arctic Energy Summit Technology Conference (AESTC) that took place in October 2007 in Anchorage, Alaska. The event featured an enormous variety of presenters, and was organized by the Institute of the North in Anchorage and co-sponsored by USARC. Such a gathering provides an unmatched opportunity for people from many different fields and nations to come together and exchange ideas, and similar events in the future should be enthusiastically encouraged.

a) Geothermal Power

An Arctic nation, Iceland, leads the world today in the use of geothermal power. Perhaps the rest of the Arctic might find geothermal energy to be the way of the future. It is domestic, virtually inexhaustible if managed correctly, and low in emissions. The technology to harness the Earth's heat is already very advanced; emissions of GHGs have actually decreased with the advent of new reinjection systems.[40] It has been proffered that enhanced geothermal systems (EGSs) might actually serve as means of storing carbon dioxide (see the "Carbon Capture and Storage" section in this report for a detailed description of carbon storage).[41] Using EGSs with supercritical carbon dioxide as a reservoir heat transfer fluid may also enhance well production and avoid the problems that water's chemistry creates.[42] Geothermal resources abound in Alaska especially,[43] with large potential in some other Arctic areas.[44] Thus, the use of geothermal as an Arctic energy resource not only has potential to supplant more carbon-intensive power production and reduce future emissions, but could also help to reduce the amount of carbon already in the atmosphere. Two challenges limit geothermal power in the Arctic regions. The first is the cost of exploration, and the second is transportation. There is large potential for hydrogen production with

[40] Presentation by Amanda Kolker, Geology PhD candidate, UAF. Anchorage Museum, 14 August 2007.
[41] "The Future of Geothermal Energy", MIT, 2006, p6.
http://www1.eere.energy.gov/geothermal/pdfs/future_geo_energy.pdf
[42] Geothermics 35 (2006) 351-367, K. Pruess. EGS with CO_2 as a working fluid.
[43] *Alaska Renewable Energy Atlas 2007*, published by the Renewable Energy Alaska Project and the Alaska Energy Authority.
[44] Digital Tectonic Activity Map of the Earth (Polar Perspective):
http://denali.gsfc.nasa.gov/dtam/downloads/ftp/dtam_poster.pdf

geothermal, as well as for transmission of geothermal energy with hydrogen when better hydrogen technologies are developed.

R&D- MIT's recently released study on the future of geothermal power outlines a number of specific R&D needs,[45] but some of the chief R&D needs for geothermal systems in the Arctic region are: remedying the remoteness between production and consumer, improved seismic sensing and monitoring to lessen start-up costs, targeted research to increase efficiency, understanding and encouraging the use of carbon dioxide as a working fluid, and improving EGS and dry cracking geothermal recovery systems.

Infrastructure Needs- While the infrastructure needed for geothermal drilling is similar to that for oil and gas drilling,[46] drilling systems could be improved. The chief infrastructure needed for an effective Arctic geothermal program, though, is a transport system to bring the power from source to consumer.[47]

Implementation Costs- Overall, because of their longevity and continuous production, with no fuel input, the operating costs of geothermal systems are far less than those of diesel energy systems. However, all of the costs of a geothermal plant are incurred at start-up because of speculative drilling and drilling production wells.[48] In addition, in areas where Enhanced Geothermal Systems (EGSs) are necessary, the already high start-up cost of a system goes up substantially.[49] The cost of a transport system for this energy will probably also be large.

Geopolitical and Cultural Considerations- Geothermal power production can offset a large percentage of domestic power production (an estimated 20% in the Alaska Railbelt alone[50]) while decreasing America's dependence on foreign fossil fuels. Geothermal also holds public appeal through its potential as a renewable home heating source (with underground heat pumps), though the cost of these systems is uncertain. Chena Hot Springs Resort in Alaska is working with the Department of Energy (DOE) to launch small-scale pilot domestic use projects, including refrigeration, heating, and running a greenhouse.[51]

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[45] See MIT study at http://www1.eere.energy.gov/geothermal/pdfs/egs_chapter_1.pdf, p. 22 for a detailed list.
[46] MIT study, p. 10.
[47] Amanda Kolker presentation
[48] Amanda Kolker presentation
[49] "Draft Strategic Plan for the DOE Geothermal Technologies Program": www.geothermal.org/DOE_presentations/JP_DOE_S.PPT
[50] Amanda Kolker presentation
[51] See Chena Hot Springs Geothermal projects website: http://www.yourownpower.com/

Feedback Issues- There are few feedback issues associated with geothermal power, so long as a reinjection system is used and the well is not overproduced. In fact, if a geothermal unit is used to capture and store carbon dioxide, it can take carbon out of the feedback cycle.

Timescale- Geothermal capability exists today, and the timescale at this point is a function of funding. The Aleutian Chain in Alaska promises a great capacity for geothermal energy, and there are currently debates about whether the community of Unalaska will convert from diesel generators. The Mt. Spurr geothermal project is in the development stages, with development applications submitted in early 2007.[52] The community of Naknek is also undertaking a large geothermal transmission project.[53]

Federal Programs- The Energy Independence and Security Act of 2007 includes funding for advanced geothermal resource detection techniques, advanced exploratory drilling techniques, EGSs, geothermal production from oil and gas fields, the establishment of a Center for Geothermal Technology Transfer, and international collaboration on geothermal technology. It also expands DOE's GeoPowering the West program into the GeoPowering America program, which covers the whole country.[54]

Short- and Long-term Benefits- The short-term benefit of geothermal power is that it can provide a low-carbon, local energy source, while in the long-term it can enhance the sustainability of the community using it, and may eventually be coupled with hydrogen transport.

b) Hydroelectric Power

Hydroelectric power is the most widespread renewable form of energy production on the planet. It supplied approximately 7% of U.S. electricity in 2006,[55] dwarfing the production from all other renewable energy sources combined, and currently supplies about 24% of Alaska's electricity.[56] It is a mature technology, and though it is widely used in Northern nations, it still has room for growth, largely because the rising prices of conventional energy sources have made various hydroelectric projects cost-competitive. In addition, studies in Scandinavia have predicted that the potential for hydro power at

52 Amanda Kolker presentation
53 Bailey, Alan. "Naknek Looks to Geothermal Energy" (6/17/2007): http://www.petroleumnews.com/pntruncate/881351375.shtml.
54 From DOE's Office of Energy Efficiency and Renewable Energy (EERE) Network News (1/2/08): http://www.eere.energy.gov/news/archive.cfm/pubDate=%7Bd%20%272008%2D01%2D02%27%7D.
55 *DOE Annual Energy Report 2007*
56 *Alaska Renewable Energy Atlas 2007*, published by Renewable Energy Alaska Project and the Alaska Energy Authority, p. 5.

higher latitudes will only increase over the course of this century with climate change.[57] This is true both for traditional large-scale projects serving dense population centers and for small "micro-hydro" projects in more remote locations. It should be noted that energy analysts anticipate that there will be negligible new hydro power development through 2020 in the U.S. as a whole, but a relatively large project (300 megawatts) at Chakachamna Lake west of Cook Inlet is currently being evaluated by TDX Power.[58] A comprehensive DOE study from 1997 identified approximately 119 possible hydro power sites of varying sizes throughout Alaska.[59]

R&D- Hydroelectric power requires little new research or development, but there is a need for further studies on the feasibility of micro-hydro power in many rural communities. Also, micro-hydro projects in cold climates face unique challenges because of ice formation in the winter.[60] These, however, must be addressed on a case-by-case basis.

Infrastructure Needs- Besides construction of the dam itself and the associated facilities, the main infrastructure required for hydroelectric projects is transmission capacity to bring electricity from the source to users. However, this is evaluated as part of the costs of the project and does not require independent study. If hydro power is developed in combination with other renewable sources, transmission infrastructure could be shared (a possibility with the Chakachamna Lake hydro power project and the Mt. Spurr geothermal project), which could reduce costs.

Implementation Costs- Costs, of course, depend on the scale of the project. If a project is appropriate for the size of the grid it serves, it may warrant even very high initial costs, as happened with the Bradley Lake hydro power project on the Kenai Peninsula.

Geopolitical and Cultural Considerations- Because of possible impacts on the local environment and the human community, the effects of a hydro power project must be thoroughly analyzed in advance. This could be especially true for micro-hydro projects in rural locations inhabited mainly by indigenous peoples, where a project's negative impacts on the environment could outweigh its benefits. However,

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[57] Arni Snorrason presentation at AESTC, "Climate and Renewable Energy in the Nordic Countries," http://www.confmanager.com/main.cfm?cid=680&nid=8815.
[58] Bailey, Alan. "A fresh look at Chakachamna hydropower." *Petroleum News*, Sept. 9, 2007: http://www.petroleumnews.com/pntruncate/839208091.shtml.
[59] Conner, Alison M. and James E. Francfort, "U.S. Hydropower Resource Assessment for Alaska," published by Idaho National Engineering and Environmental Lab on behalf of DOE in November 1997: http://hydropower.id.doe.gov/resourceassessment/pdfs/states/ak.pdf.
[60] Brian Yanity presentation at AESTC, "Cold Climate Problems of a Micro-Hydroelectric Project on Crow Creek, Alaska," http://www.confmanager.com/main.cfm?cid=680&nid=8815

hydro power has the advantage of being the oldest and most widely accepted source of renewable energy, and it reduces dependence on foreign oil and thereby enhances energy security.

Feedback Issues- Hydroelectric projects have few associated feedback issues with regard to carbon emissions, but, depending on scale, they can have significant impacts on the surrounding environment. A dam can decrease water levels downstream, cause low oxygen levels in the water downstream, and prevent fish from reaching either the spawning grounds upstream of the dam or the ocean downstream (though methods to mitigate this problem, such as fish ladders, have been deployed in some cases).

Timescale- As with geothermal, hydro power is immediately deployable, and depends only on financing. Given the large initial investment, the careful study needed in order to prove a project viable may delay it for years.

Federal Programs- Federal support for hydro power projects appears to be at a low, because its potential for growth is small compared with other renewable sources, and because of increasing regulatory difficulties and energy economics. However, DOE still maintains some hydropower funding through the Office of Energy Efficiency and Renewable Energy's (EERE) Wind and Hydropower Technologies Program. This program focuses not on significant new technology, but rather on improvements of turbine efficiency and on reducing the environmental impact of hydro facilities.[61]

Short- and Long-term Benefits- In the short term, hydro projects can create local jobs and reduce the amount of money leaving the community to pay for fossil fuels. In the longer term, they reduce carbon emissions and, though they are vulnerable to fluctuations in water flow, they provide local and perpetual sources of reliable, clean base-load energy.

c) Wind Power

Wind power is by far the fastest-growing source of renewable energy in the U.S. Installed wind capacity grew by an impressive 45% in 2007,[62] but it still represents less than one percent of total electricity generation. It has received perhaps the greatest media attention of any of the renewables in recent years, and promises to make a substantial contribution to reducing dependence on fossil fuels. Wind power has

[61] See EERE's Wind and Hydropower Technologies website: http://www1.eere.energy.gov/windandhydro/.
[62] "U.S. Wind Capacity Up 45 Percent in 2007," from RenewableEnergyAccess.com, 1/18/2008: http://www.renewableenergyaccess.com/rea/news/story?id=51180.

great potential for expansion in Northern regions. In Alaska, those regions lie mainly—though not exclusively—on the coast, and include both the population centers of the Railbelt and many rural communities. There are several studies underway for wind projects in the Railbelt, such as the proposed site on Fire Island near Anchorage, and many remote villages have plans to incorporate wind power in the near future. The Alaska Village Electric Cooperative has already installed wind turbines in several villages, and eventually intends to install them in 27 out of the 53 communities it serves.[63] As expected, this trend is being driven by rising diesel prices and uncertain natural gas markets.

R&D- The technology of wind turbines is mature relative to many other renewables, such as photovoltaics and wave and tidal systems, and so further research should concentrate on ancillary technologies. The most important of these is storage mechanisms. Since the wind does not always blow, nor does it often blow strongly at times of peak electricity demand, excess power generated by wind turbines has the potential to overload the grid to which it is connected, or to be wasted. Thus, storage of wind power appears to be a primary factor hindering wider deployment, and no perfect solution has yet emerged. Utilities like American Electric Power are investing in large-scale chemical batteries for storage.[64] A small community in Norway is demonstrating the possibility of a system in which excess power from a wind turbine drives the production of hydrogen, so that the stored hydrogen can be used to produce electricity when the wind does not supply sufficient power.[65] (Hydrogen technology is discussed below.) Another option is Compressed Air Energy Storage (CAES), which works by using wind power in order to compress air in a special vessel, and then releasing that compressed air in order to produce electricity when it is needed.[66] Still another option is combining wind power with a hydroelectric system, so that wind power pumps water up to a higher elevation, and the water can be released on demand to drive a conventional hydro turbine, an option employed in Scandinavia.

Infrastructure Needs- Besides the need for storage, large-scale wind projects usually require new transmission infrastructure, and there are often extra costs for integrating wind power with the existing grid. This points to a general need for "smart grid" technology (discussed in greater detail below), which allows utilities to more effectively manage electricity production and demand. In addition, better systems

[63] De Marban, Alex. "Wind power gains strength as rural energy alternative." Anchorage Daily News, 1/22/2008: http://www.adn.com/front/story/290021.html.
[64] Wald, Matthew L. "Utility Will Use Batteries to Store Wind Power." New York Times, 9/11/2007: http://www.nytimes.com/2007/09/11/business/11battery.html?ref=business.
[65] David Pointing presentation at AESTC, "The NordSESIL.net Project," https://www.confmanager.com/main.cfm?cid=680&nid=8811
[66] Marcus, David. "Moving Wind to the Mainstream: Leveraging Compressed Air Energy Storage." From RenewableEnergyAccess.com, 10/1/2007: http://www.renewableenergyaccess.com/rea/news/reinsider/story?id=50123.

are needed in isolated grids, such as those in rural Alaska, for integrating wind (and other renewable) power with the diesel generators that currently supply nearly all of the electricity in those places. Wind-diesel hybrid systems come in three main forms, classified according to whether wind has low, medium or high penetration in the system; the three types are essentially separate technologies.[67] Many of the presentations at AESTC emphasized that wind power can displace a portion of diesel use in many communities, but only if it can be reliably integrated with diesel power, and only if it enjoys wide community support. Thus, technological and community decision-making infrastructure are critical to the successful deployment of wind power in remote rural settings. One other infrastructure need is greater turbine manufacturing capacity. Because of the tremendous growth nationwide in wind power, all wind turbine plants have sold out their manufacturing capacity for 2008.[68] Additionally, wind turbine production has become focused on large-scale turbines, and production of smaller turbines appropriate for rural Alaska has lagged behind. Clearly, there is a need and a possible opportunity for local production of wind turbines.

Implementation Costs- For average wind power projects connected to large grids, the majority of cost stems from initial investment in the turbines themselves and installation, with much less spent on maintenance and operations. These projects, therefore, require well-established demand and transparent regulatory processes in order to secure funding, but once installed they face relatively few risks. Projects in isolated rural communities like the villages of Alaska face the additional challenges of shipping and installing the turbines in remote and difficult environments, and then maintaining them with infrequent support through cold winters. The cost of the turbine, normally the largest expense, is often overshadowed by shipping, installation, and maintenance costs in these situations. Despite this, the rapidly rising cost of diesel has made wind power economical in many locations.

Geopolitical and Cultural Considerations- Wind power, along with the other forms of renewable energy, provides the important benefit of reducing fossil fuel use and increasing domestic energy security. Culturally, the installation of wind power in rural villages may provide a way of bringing the community together in order to develop a coordinated plan for energy use. People in many Alaskan villages eagerly seek out the opportunity to implement wind power.

[67] Edward Baring-Gould presentation at AESTC, "Status of Wind/Diesel Applications in Arctic Climates," https://www.confmanager.com/main.cfm?cid=680&nid=7255.
[68] "U.S. Wind Capacity Up 45 Percent in 2007."

Feedback Issues- Wind power has few associated feedback issues, but it does have the potential for somewhat minor environmental impacts. These include harm to birds, noise, and aesthetic alteration of the landscape.

Timescale- As noted, wind power is relatively mature as a technology and can be deployed readily given the right economic conditions, and given preliminary testing of the resources of an area.

Federal Programs- DOE's Wind and Hydropower Technologies Program supports research related to storage mechanisms (specifically, combining wind power with hydrogen or hydroelectricity) and grid integration issues. This program, however, does not address Arctic-specific needs. DOE's Wind Powering America program provides a small amount of support to wind projects in Alaska, including an anemometer loan program, consumer guides, and a wind working group. The Energy Security and Independence Act of 2007 directed DOE to establish a cost-sharing R&D program for the development of effective energy storage mechanisms; this could potentially help fund research into better storage for wind power. It should also be mentioned that the federal wind energy PTC—currently valued at 1.9 cents per kilowatt-hour for the first ten years a project operates—is currently vital to the success of a large number of wind projects nationwide. Similar PTCs are also critical for other renewables: geothermal, solar, and some bioenergy projects.[69]

Short- and Long-term Benefits- Despite the unpredictability of wind availability and the need to develop storage mechanisms and smooth integration with existing grids, wind power is an effective means of tapping a resource that abounds in many Northern regions, especially Alaska. It reduces fossil fuel dependence and increases energy security, provides local jobs, and can serve as a rallying point for communities facing energy crises. Recent experience in Alaska also suggests that planning on the regional level may be very effective in some cases for helping to develop and implement individual community wind energy plans.[70] Realistically, though, wind energy cannot provide for all or even the majority of a typical community's needs, at least in the short term. Kotzebue, which has invested the most in wind power of any rural Alaskan community and installed more than 15 turbines (which add up

[69] "Renewable Energy Tax Credit Extended Again, but Risk of Boom-Bust Cycle in Wind Industry Continues," from Union of Concerned Scientists website (1/26/2008):
http://www.ucsusa.org/clean_energy/clean_energy_policies/production-tax-credit-for-renewable-energy.html
[70] Martina Dabo presentation at AESTC, "Regional Economic Wind Development in Rural Alaska":
https://www.confmanager.com/communities/c680/files/hidden/Presentations/Rur-14_Regional_Wind_Power_Alaska.pdf.

to over one megawatt of capacity), receives only 5-7% of its power from wind.[71] Still, installation of wind power can reduce energy costs and begin the path toward a more sustainable local energy system.

d) Solar Power

Solar power faces special challenges in Northern regions like Alaska. Although the state receives a large amount of solar radiation in the summertime, electricity demand is greatest in the wintertime when the sun provides little energy. Because of this mismatch, most studies indicate that solar power on a large scale is not cost-effective in the Arctic. The remote town of Lime Village maintains the largest utility-connected solar capacity in the state, a photovoltaic-diesel-battery hybrid system that generates only 12 kilowatts. Various studies are continuing, however, to assess solar power's viability. For instance, solar may become cost-effective if coupled with other renewables, as is being done in a study at the Cold Climate Housing Research Center in Fairbanks, Alaska.[72] One Nome business recently installed 92 solar panels at a cost of $175,000, and expects them to offset 10-15% of its office building's electricity consumption.[73] In any case, solar power remains a good option for remote cabins or stations with small needs and limited access to other energy sources. Solar water heating systems work well during a large portion of the year, and may eventually provide in-floor heating if such technology becomes commercialized and widely available.[74] Given the ongoing large research investments from both the public and private sectors, and constant advances in solar technology, cost reductions may eventually make solar power a more attractive option in the Arctic.

e) Wave, Tidal and Osmotic Power

All three of these technologies generate electricity by the harnessing the kinetic energy of moving water, and all tap into energy sources that are more predictable and denser than wind and solar. Though wave and tidal energy have been under development for some time, recent advances have made them more feasible in many locations. However, the technology is still immature relative to some other renewable sources like wind.

[71] Brad Reeve presentation at AESTC, "Renewable Energy and Energy Planning in Northwest Alaska": http://www.confmanager.com/main.cfm?cid=680&nid=8815

[72] See the Hybrid Micro-Energy Project page at the Cold Climate Housing Research Center website: http://www.cchrc.org/research.html.

[73] "Fuel costs strap the Bush," Anchorage Daily News, 12/18/2007: http://dwb.adn.com/opinion/view/story/9526030p-9436814c.html

[74] *Alaska Renewable Energy Atlas 2007*, p. 14.

Wave energy generation systems differ in the methods used to convert kinetic wave energy into electric energy, but one good example is the AquaBuOY unit developed by Finavera Renewables, Inc. This unit uses wave energy to drive pressurized seawater through a series of hoses; the seawater then drives a turbine which produces electricity. In December 2007, Finavera became the first company in the U.S. to obtain a license from the Federal Energy Regulatory Commission (FERC) for commercial wave energy power generation, and also the first in the U.S. to sign a purchase agreement for wave power.[75] Finavera is still testing its technology, but the license and contract prove that it is a real possibility, and they could pave the way for other companies and technologies. Large-scale, feasible wave energy appears to be on its way in the U.S. Though the southern coast of Alaska possesses some of the most abundant wave resources in the world, there are currently no wave projects under development, because of the remoteness of most of the wave energy from demand centers. Some communities, however, such as Yakutat, may provide suitable sites.[76]

Tidal power systems (which, with wave power, fall under the term "ocean" or "marine" energy) also come in a wide variety of designs, though most use the water flow of the tides in order to drive a turbine. Cook Inlet in Alaska happens to possess some of the strongest tidal resources in the world, and a 2006 study concluded that a site at Cairn Point in Knik Arm could produce approximately 17 megawatts.[77] Ocean Renewable Power Company will be testing a newly-developed tidal turbine technology at Port MacKenzie and/or a more remote Alaskan site in mid-2008. The company then hopes to obtain FERC permits for commercial generation in 2010 and install its first commercial project by 2012.[78] Though this company is the first, other tidal power firms will most likely enter the Alaska market in the future due to the large resource potential, and its relative proximity to the large population center of Anchorage and the Railbelt grid. No one is certain how tidal development would be affected if the beluga whale in Cook Inlet is listed as an endangered species.

Osmotic power is even less mature than wave or tidal, but holds some promise. An osmotic power project must be located at an estuary, where freshwater meets saltwater. The plant brings in both types of water and separates them with a semi-permeable membrane. The natural process of osmosis causes the freshwater to diffuse through the membrane and increase the pressure on the saltwater side, and that pressure is then converted into electricity. The Norwegian-owned renewable energy group Statkraft plans

[75] "Wave Power Going Commercial with License and Power Contract," from EERE Network News (1/9/2008): http://www.eere.energy.gov/news/archive.cfm/pubDate=%7Bd%20%272008%2D01%2D09%27%7D
[76] *Alaska Renewable Energy Atlas 2007*, p. 12.
[77] *Alaska Renewable Energy Atlas 2007*, p. 12.
[78] Ocean Renewable Power Company presentation at AESTC, https://www.confmanager.com/communities/c680/files/hidden/Presentations/Ren-16_Alaska_Tidal_Project.pdf

to construct a prototype osmotic plant of two-to-four kilowatt size in 2008 in Norway, in order to demonstrate the technology's feasibility.[79] It claims that osmotic power will be economically competitive with other renewables within ten years.[80] At this early stage of development, the feasibility of the system is hard to estimate, and there are no specific assessments of its potential in Northern regions.

R&D- Though wave and tidal power are now approaching commercial viability, further research will undoubtedly be required to refine the designs for each as the technologies mature. Current investments in research, development and demonstration of wave and tidal power projects are hampered by the fact that very limited federal support currently exists, whether in the form of research funding or in the form of production subsidies. Though other companies have investigated it, Statkraft remains the world leader in the development of osmotic power, and will likely continue to pursue its aggressive goal of commercializing it within a decade.

Infrastructure Needs- While wave projects in the continental U.S. will most likely be developed in areas close to population centers, wave resources in Alaska are greatest in areas far from most electricity use. Thus, public investments will probably be required in order to attract private sector interest in developing this vast potential. Perhaps wave energy could be stored and transported through a hydrogen system. In any case, the development of wave power would create the need for significant supplemental infrastructure. By contrast, the world-class tidal resources of Cook Inlet are in a much better position because of their proximity to the Railbelt grid, and would require very little extra infrastructure. The same goes for osmotic power; a large number of the world's estuaries are home to cities, and so an osmotic power project could easily be sited very close to demand.

Implementation Costs- Initial costs are high for wave and tidal, but extensive studies by the Electric Power Research Institute (EPRI) suggest that with advancements in technology it will likely become competitive with other renewables within about a decade.[81] Osmotic power faces similar high initial costs, but the technology is so immature that Statkraft is not yet certain at this point that it can make the process economically feasible.[82]

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[79] "Statkraft to build world's first osmotic power plant," from Pure Energy Systems Network (3/10/2007): http://pesn.com/2007/10/07/9500451_Statkraft_osmotic_power_plant/

[80] Statkraft, "Osmotic Power: A huge renewable resource." http://www.statkraft.de/Images/Statkraft%20Osmotic%20Power_tcm4-5362.pdf

[81] Roger Bedard presentation at the Duke Global Change Center, "Overview: EPRI Ocean Energy Program" (9/14/2006): http://oceanenergy.epri.com/attachments/ocean/briefing/Duke_Sep_14.pdf.

[82] Berzon, Alexandra, "Salty Power: A Norwegian company seeks to harness power where salt water and fresh water meet" from Greentech Media (10/5/2007): http://www.greentechmedia.com/articles/salty-power-164.html.

Feedback- These forms of energy cause no carbon emissions, and very few environmental impacts. Wave energy projects have proven quite benign, with only minor concerns about conflicts with other human activities that use the sea space near shore. Tidal turbines may endanger some fish species, but not significantly. Neither causes aesthetic issues—as offshore wind projects might—because they are usually located either underwater or far enough offshore to be out of sight. Osmotic power also poses minimal environmental problems.

Timescale- Given the number of companies currently working to test and commercialize wave and tidal power, the fact that Finavera has signed a purchase agreement to supply power in northern California beginning in 2012, and the fact that Ocean Renewable Power Company plans to have a commercial unit operating by 2012, it appears that both technologies could provide significant amounts of electricity within a decade. Once commercial units are developed and scaled up, deployment could happen relatively quickly. The UK company Ocean Power Delivery, in fact, has already produced and sold the most mature wave energy device on the market, called the Pelamis.[83]

Federal Programs- The Energy Security and Independence Act of 2007 instructed DOE to create a small program for the support of ocean energy, and also to award grants to universities for the creation of National Marine Renewable Energy Research, Development and Demonstration Centers.[84] This is a modest, but important, beginning. Given the large resources in Alaska, it may be wise to devote significant funds to Northern ocean energy. Still, a PTC does not exist for any ocean energy technology, which is a major barrier to further deployment. EPRI, after its extensive studies of wave and tidal energy, recommends that the government investigate the possibility of a PTC and/or RECs for these technologies, and that it help to streamline the regulatory process for licensing and permits. The United Kingdom has been a long-time supporter of ocean energy, and may provide a good model of government support of the technology. The UK and Portugal both have plans to install marine energy projects in the next few years. The UK has established a European Marine Energy Centre, and even funded a "Wave Hub" project, a central facility connected to the mainland to which other marine energy projects can attach.[85] The U.S. government could benefit greatly from collaborating with other nations, like the UK, whose programs are more advanced. The lack of osmotic power development in the U.S. suggests that the technology may not yet merit government support.

[83] Roger Bedard presentation

[84] From DOE's Office of Energy Efficiency and Renewable Energy (EERE) Network News (1/9/2008): http://www.eere.energy.gov/news/archive.cfm/pubDate=%7Bd%20%272008%2D01%2D02%27%7D.

[85] Roger Bedard presentation

Short- and Long-term Benefits- Like other renewables, these technologies promise clean energy from abundant and inexhaustible sources, and also the creation of local jobs and the reduction of fossil fuel use. Besides that, these methods have the added benefit of being more predictable, denser in energy, and less intermittent than sources like solar and wind. Beyond the short-term, it is possible that tidal technology could be adapted to "run of river" applications, and also that both wave and tidal projects could be combined with offshore wind projects in order to reduce costs.[86]

f) Biomass Power

"Biomass" is a very general term that includes a wide range of organic materials that can be converted into energy, everything from food crops like corn and soybeans to particular types of algae capable of producing biodiesel fuel. However, biomass resources in the Arctic are not quite so varied. In Alaska, the main biomass resources are wood, sawmill wastes, fish byproducts and municipal waste.[87]

Alaska uses approximately 100,000 cords of wood per year for heating purposes, and so wood constitutes an important renewable resource for the state. After the closure in the 1990s of the pulp mills in Sitka and Ketchikan, large-scale wood-fired power generation came to an end, but rising fuel prices have again generated interest in using wood and wood waste for power generation and possibly for ethanol production.[88] For example, a wood-powered district heating system for Craig, Alaska is currently in design.[89] Villages in the Bethel area are currently considering commercial firewood harvests around the Kuskokwim River.[90] Nordic countries as a whole generate 14% of their energy from biomass, and Sweden generates about 48% of its district heating energy from biomass, with the other Nordic nations falling between fifteen and eight percent.[91] If district heating becomes more widespread in Alaska, biomass may provide an excellent energy source. In addition, wood energy in the wintertime could be combined with solar energy in the summertime in order to provide a year-round hybrid renewable energy source. The Cold Climate Housing Research Center in Fairbanks is currently testing such a system.[92]

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[86] Roger Bedard presentation
[87] *Alaska Renewable Energy Atlas 2007*, p. 6.
[88] *Alaska Renewable Energy Atlas 2007*, p. 6.
[89] Alaska Energy Authority website: http://www.aidea.org/AEA/programsalternativebiomass.html.
[90] Bluemink, Elizabeth. "Nome group taps sun for power." Anchorage Daily News (12/2/2007): http://dwb.adn.com/news/alaska/rural/story/9493939p-9404794c.html.
[91] Jorgenson, Birte Holst, "Bioenergy—The Future of Renewable Energy?" from Nordic Energy Research (12/20/2007): http://www.nordicenergy.net/onenews.cfm?Id=3-99&path=8.
[92] Associated Press. "Researchers test energy potential of winter sun," from Anchorage Daily News (12/23/2007): http://www.adn.com/news/environment/story/245096.html.

Fish byproducts have great potential in Alaska as an energy resource, since fish processing operations in the state annually produce approximately thirteen million gallons of fish oil waste. This oil can either be mixed with conventional diesel in a traditional boiler system or manufactured into biodiesel. UniSea, Inc., a fish processing company in Dutch Harbor, currently uses up to one million gallons per year of a 70% fish oil-diesel mixture in order to power its operations. Some groups in larger Alaskan cities reuse cooking oil for heating and transportation fuel.[93] Thus, biomass in the form of oils offers a significant resource for both commercial and personal use that would otherwise be entirely wasted. Locally-made biodiesel offers a particularly attractive opportunity for rural communities, which depend almost entirely on diesel, to obtain their fuel from renewable sources and to reduce their carbon emissions.

Municipal waste, in the larger cities of Anchorage and Fairbanks especially, offers another potential energy source that would otherwise go unused. A 2005 study concluded that methane gas from the landfill in Anchorage could provide a feasible source of the equivalent of 2.5 megawatts of electricity or 1.9 millions gallons of diesel per year for the next ten years. Eielson Air Force Base near Fairbanks uses densified paper waste from the city in its coal plant, which provides up to 1.5% of the base's heat and power.[94]

R&D- R&D needs for the biomass options available in Alaska are generally limited. Wood-fired technology requires little. Many studies have demonstrated the viability of fish oils as fuel. Extraction and conversion of landfill gas is a proven technology already operating in hundreds of locations, though its feasibility depends on the presence of a large enough gas source. Paper waste is easily burned in a coal-fired power plant. In each case, future improvements in efficiency and design will bring down costs and enhance the ability of each to compete with conventional energy sources.

Infrastructure Needs- Again, these vary greatly. On the whole, biomass power is more flexible with regard to location, since the resource is usually portable, than wind, geothermal, etc. Thus, biomass tends to require much less ancillary infrastructure development than more remote renewable energy sources. Despite fish oil biodiesel's great potential in Alaska, economic feasibility studies—conducted jointly by the Alaska Energy Authority, the Alaska Department of Environmental Conservation, the University of Alaska Fairbanks' (UAF) Arctic Energy Technology Development Laboratory (AETDL), and the

[93] *Alaska Renewable Energy Atlas 2007*, p. 6. For information about local groups, see www.alaskabiodiesel.com and www.alaskabiodiesel.org.

[94] *Alaska Renewable Energy Atlas 2007*, p. 6.

National Park Service—are still in progress to determine whether local large-scale biodiesel production facilities in the state would be cost-effective.[95] Such facilities would greatly enhance advance the use of biodiesel in Alaska.

Implementation Costs- Costs appear to be relatively low for sources like fish oil, where the main cost is the facilities for capturing the oil and mixing it with diesel or manufacturing biodiesel; however, the equipment for converting it into biodiesel would have high initial costs. The great advantage of biodiesel is that it can be used in normal diesel engines, whereas raw fish oil can only be used as a part of a mixture. Landfill gas extraction also requires a high initial investment. Thus, costs vary by the biomass source, but on the whole they have usually been found to be worth the investment. The use of biomass in combined heat and power systems (discussed below) has the potential to maximize energy output per unit of fuel and therefore make biomass even more feasible; in fact, the majority of current biomass energy comes from combined heat and power systems.

Feedback- If living trees in the Arctic were to be harvested specifically as a form of biomass energy, this would clearly affect the carbon sink of the boreal forests, but biomass usually refers to waste material that would otherwise go unused, at least by humans. Thus, appropriate use of wood biomass would not significantly increase carbon emissions or affect carbon sinks. Fish oil mixed with ordinary diesel, or converted into biodiesel, produces substantially fewer carbon emissions than diesel alone. The use of both paper waste and landfill gas reduces carbon emissions: garbage, as it decomposes in a landfill, naturally releases considerable amounts of carbon dioxide, methane and other trace compounds, and landfill gas extraction prevents a portion of this carbon from entering the atmosphere, while converting it into useful energy. The burning of paper waste reduces carbon emissions first by reducing the volume of waste in the landfill, and second by offsetting some of the coal used in a coal plant.

Timescale- All of the biomass energy sources discussed here are currently in use, and could be developed quickly if funded.

Federal Programs- Current federal investments in biomass energy focus mainly on the production of biofuels for automobiles. The large-scale production of biodiesel from fish oils may eventually help to meet the federal Renewable Fuel Standard, which mandates that the U.S. produce 7.5 billion gallons of biofuel annually by 2012, and even more in the following years. This focus on biofuels, while it may be good for fish oils, means that federal agencies have directed little funding toward wood biomass, except

[95] Alaska Energy Authority website: http://www.aidea.org/AEA/programsalternativebiomass.html.

as a source of cellulosic ethanol. Landfill gas projects, however, receive a PTC under federal law of one cent per kilowatt-hour for the first ten years of operation, and so enjoy a considerable subsidy.

Short- and Long-term Benefits- In addition to providing renewable energy in the short term, biomass reduces the human waste stream by harnessing energy stored in that waste. The sustainability of society depends in large part on its ability to use energy efficiently and recycle materials, and so in the long term, biomass energy contributes to sustainability.

g) Hydrogen and Fuel Cell Technology

Hydrogen, as a carrier of electricity, holds great potential for the future, especially when coupled with renewable energy-generation technologies. Elemental hydrogen can be produced in many ways, e.g. from hydrocarbon sources or from water by electrolysis; in either case, energy must be expended in order to separate hydrogen from the hydrocarbon or water. The hydrogen so produced must be stored in a vessel of some kind, transported, and then consumed at the end-use point. Because of inefficiencies in current methods, hydrogen production and transport are energy sinks and will probably remain so, but research into these areas will greatly benefit future energy transport, since the technology offers a carbon-free energy carrier mechanism that takes advantage of the most abundant element in the universe.

At the moment, Iceland is the nation most aggressively developing hydrogen energy infrastructure—its stated goal is the use of hydrogen to power all transportation in the country by 2050.[96] Because it obtains almost all of its other energy from hydroelectric and geothermal facilities, it could become the first country to power itself completely with carbon-free energy sources. The U.S. maintains a partnership with Iceland that focuses on rapid development of hydrogen, and both are part of the International Partnership for the Hydrogen Economy (IPHE), an organization of 15 developed nations and the European Commission that promotes the advancement and deployment of hydrogen technology and fuel cells.[97]

While "hydrogen technology" refers to the use of hydrogen as a fuel source, the term "fuel cell" refers to a particular type of mechanism that directly converts chemical to electrical energy. The two are separate technologies, but they go hand in hand. A fuel cell is divided into two compartments, separated by a

[96] Icelandic New Energy Ltd. presentation at AESTC, "Hydrogen Economy Meeting Future Energy Needs: Arctic Vision," https://www.confmanager.com/communities/c680/files/hidden/Presentations/Ren-09_Hydrogen_Economy.pdf.
[97] IPHE website: http://www.iphe.net/

special membrane, called the electrolyte. In the typical fuel cell, hydrogen enters the first compartment, where a catalyst (often platinum or a similar metal) causes the hydrogen to dissociate into protons and electrons; the membrane allows only the protons to diffuse through to the other compartment, while directing the electrons through an external circuit, where this electron flow generates electricity. The electrons and protons combine with oxygen in the other compartment in order to form water, and release a large amount of heat in the process. Of course, variations of this basic fuel cell type exist, which use hydrocarbons such as methanol rather than pure hydrogen as fuel.

Dennis Witmer, of the AETDL at UAF, identifies five main types of electrolytes used in fuel cells: alkaline, phosphoric acid, molten carbonate, solid oxide, and polymer exchange membrane (PEM). Witmer believes that alkaline is not viable on any large scale, that phosphoric acid is commercialized but still too expensive, that molten carbonate is still in the pre-commercial development stage, that solid oxide is promising but still too expensive, and that PEM units still degrade too quickly. His main conclusion is that hydrogen and fuel cell infrastructure will not become viable until consumers are willing and able to pay more for energy than they currently do.[98]

R&D- Despite decades of research and development, hydrogen and fuel cell technology still faces significant challenges before it can become a widespread replacement for the current fossil fuel infrastructure. First, there are concerns about the efficiency of hydrogen production. As noted, hydrogen would function more like electricity than gasoline, i.e. as an energy carrier rather than an energy source. Approaches to hydrogen production still differ greatly. And, as Witmer observes, further research into electrolytes and other technical components of the fuel cell is needed in order to improve efficiency and durability. Almost every aspect of the storage, distribution and transportation of hydrogen remains a concern—including the cost of storing high-pressure hydrogen gas or liquefied hydrogen, the safety of storing hydrogen (given its instability in elemental form), and the distribution mechanisms for hydrogen (whether it would be produced at central plants or at decentralized locations resembling today's gas stations). Research in all of these areas will likely continue for decades to come.

Infrastructure Needs- The development of a "hydrogen economy" is a long-term goal and is by no means a certainty at this point, because much research is still required, and also because it will necessitate a massive investment in infrastructure over a considerable period of time. Cost-effective, safe and reliable technology for the production, storage, and transportation of hydrogen and for fuel cells may not

[98] Dennis Witmer presentation at AESTC, "Hydrogen and Fuel Cell Demonstrations in Alaska," http://www.confmanager.com/main.cfm?cid=680&nid=8813.

be available for well over a decade, and will probably not achieve substantial market penetration until years after that. Essentially, an entirely new energy infrastructure would be necessary in order for hydrogen technology to displace fossil fuels. There are some ideas, however, for employing existing infrastructure; one of these is the use of natural gas pipelines for the transport of hydrogen.

Implementation Costs- The costs of implementing hydrogen technology will be high not only because of the large infrastructure investment needed, but because the price of hydrogen production and of fuel cells is likely to remain high for the foreseeable future.

Feedback- The typical fuel cell which uses pure hydrogen emits no carbon, while fuel cells using various hydrocarbon sources do produce carbon emissions, although in small amounts compared to internal combustion engines. If the energy for the production of hydrogen comes from fossil fuel sources, the entire hydrogen infrastructure may cause substantial emissions; therefore, it is important that hydrogen technology be coupled with renewable energy sources.

Timescale- The timescale for deployment is still uncertain at this point, because of the uncertainty about the rate at which hydrogen and fuel cell technology will be commercialized. Most likely hydrogen will not have a substantial impact in the U.S. or in the Arctic (except Iceland) for at least a decade.

Federal Programs- The CCTP's near-term goal for hydrogen and fuel cell development is to research and develop all the technologies supporting the envisioned "hydrogen economy" at a pace such that a decision can be made by 2015 about the long-term viability of hydrogen and fuel cell infrastructure for energy storage, transportation needs, electricity generation, etc.[99] Federal programs like DOE's Hydrogen, Fuel Cells and Infrastructure Technologies Program tend to focus on the development of hydrogen technology for the auto market, and only secondarily on stationary fuel cells and energy storage. In any case, the infusion of billions of dollars of federal money into the industry, which currently struggles largely because of a miniscule market, will undoubtedly enable it to advance far more quickly than would otherwise be possible. There are no federal programs that specifically address the development of hydrogen and fuel cell technology for the Arctic, though the Norwegian wind-hydrogen system mentioned above indicates that there may be an opportunity for a similar demonstration project in Alaska.

[99] *U.S. Climate Change Technology Program Strategic Plan*, September 2006, p. 90.

Short- and Long-term Benefits- Though hydrogen is often touted as the future of energy and a solution to dependence on imported fossil fuels, it should be remembered that hydrogen is an energy carrier, and that it can only reduce carbon emissions if it is produced using renewable energy sources or sources that incorporate carbon sequestration. Thus, the development of hydrogen and fuel cell technology should only be pursued in the context of a long-term policy to reduce carbon emissions from all primary energy sources. One of hydrogen's greatest benefits, in fact, may stem from its use as a store for the energy produced by intermittent renewable sources like solar and wind, and not from its use as an automotive fuel. This may be particularly true for rural Arctic communities with abundant renewable energy resources, where hydrogen could be used to store the energy for local use and also for export.

h) Nuclear Power

Though nuclear power is regarded as a conventional power source, the fact that it contributes little or no carbon to the atmosphere means that it can be an important part of a carbon mitigation portfolio. It has been a major commercial supplier of power for decades, and is therefore well-established, though it has often faced fierce citizen opposition, especially after the incidents at Three Mile Island and Chernobyl, and fears about nuclear proliferation. In the face of climate change impacts, rising energy costs, and increasing security concerns, nuclear power appears to be making a comeback in the U.S.[100] and some European countries, and constitutes an integral part of the energy strategy of developing nations like China. Among Arctic nations, Sweden overshadows all others, deriving about 46% of its electricity from nuclear, while Finland uses nuclear for 28% of its electricity.[101] Currently, only one nuclear project has been proposed in Alaska, in the small community of Galena. It would be the first non-military reactor in the state. Though the project is moving forward, and has the potential to provide low-cost energy for Galena, it faces strong skepticism and could end up costing much more than planned by the time it is installed in 2012.[102] But if the reactor is built and lives up to promises, it could generate enough excess power to produce hydrogen for fuel cells, and also enough heat for a district heating system.

R&D- Though nuclear technology is quite mature, ongoing research continually seeks to develop new better reactor types and improve the efficiency of existing plants. One example is the new, small and relatively simple design of the Galena reactor, proposed by the Toshiba Corporation of Japan. Many

[100] "Companies File the First Nuclear Plant Application in 29 Years," from EERE Network News (9/26/2007): http://www.eere.energy.gov/news/archive.cfm/pubDate=%7Bd%20%272008%2D01%2D09%27%7D.
[101] Arni Snorrason presentation at AESTC, "Climate and Renewable Energy in the Nordic Countries," http://www.confmanager.com/main.cfm?cid=680&nid=8815.
[102] Gay, Joel, "Village invited to test cheap, clean nuclear power," from Anchorage Daily News (10/21/2003): http://dwb.adn.com/front/story/4214182p-4226215c.html.

agree that the new design should work well in theory, but it has never been tested, and U.S. regulators require the construction of a prototype before the actual plant is built. The performance of the prototype should indicate the viability of this new reactor type.

Infrastructure Needs- The main supplementary infrastructure associated with nuclear power is a method for disposal of the nuclear waste generated. This need remains a significant problem for future development of nuclear power, since the proposed federal disposal site at Yucca Mountain has yet to be approved. Nuclear reactors are usually sited near demand, so they do not require significant investments in transmission lines.

Implementation Costs- Initial costs are high for nuclear power projects, because of the size and complexity of the projects and because of the price of insurance required to cover the costs of a possible accident. The final cost of the Galena reactor is still uncertain because the design is unproven, but it is likely to be less than a standard plant, due to its small size and relatively low potential for an accident.

Feedback- Nuclear power emits no carbon, but it does pose the significant environmental problem of nuclear waste disposal.

Timescale- Regulatory hurdles and the size of nuclear projects generally cause about a ten year delay between the proposal of a nuclear plant and its completion. Since the technology is well-established, funding, regulation and popular opposition are the main factors affecting the deployment of nuclear power.

Federal Programs- President Bush's National Energy Policy[103] declares that the nation's growing need for base-load electricity generation can and should be partially met by the development of new nuclear plants, and it now appears that new nuclear capacity will be coming online in the next decade. No federal plans exist for the development of nuclear energy in the Arctic.

Short- and Long-term Benefits- Though the waste disposal problem remains a significant issue, a small and relatively safe reactor like the one proposed for Galena could prove to be an important model, if it is successful. For some rural Arctic communities, such reactors could reduce energy costs substantially. In the longer term, however, more sustainable and less risky energy sources should be preferred.

[103] *National Energy Policy: Report of the National Energy Policy Development Group*, May 2001.

4) Energy Conservation and Efficiency Measures

Above-average energy prices, especially in the rural Arctic, provide strong incentives for the adoption various practices and technologies that can reduce overall energy use, and also reduce the intensity of energy use. Thus, the measures discussed here may be feasible and desirable in the Arctic earlier than elsewhere. This does not constitute an exhaustive list by any means, only a selection of particularly appropriate strategies for the Arctic.

a) Personal Conservation and Efficiency, and Community Planning

As is often said, voluntary energy conservation and efficiency by individual citizens and businesses constitutes the cheapest and quickest way to reduce energy use and carbon emissions. Of course, such conservation, in order to have a significant impact, must take place on a large scale. This requires education about environmental issues and energy use. Though conservation cannot mitigate climate change on its own, and the development of other mitigation strategies like carbon sequestration are important, carbon mitigation should begin with education in order to be most effective. This awareness must then inform not only personal actions like deciding to turn down the thermostat or buy an energy-efficient appliance, but also extend to the community level, informing local planning processes and prioritizing issues of sustainability. The recently published Fairbanks energy plan[104] provides a good example in the Arctic of how an awareness of sustainability issues can lead to a holistic planning approach and a broad community commitment to pursuing the best—and not necessarily the cheapest—option when it comes to energy production and consumption. A sharing of "best practices" among Arctic nations may be a worthwhile endeavor.

At the individual level, energy conservation can take many forms: personal actions such as carpooling; walking or biking instead of driving when possible; turning down the thermostat and using less hot water; cutting back on personal electronics and unplugging appliances when not in use; and also consumer choices, such as buying energy-efficient appliances and lighting; buying less fuel-intensive cars; installing solar panels or other small-scale renewable energy sources; and buying locally harvested food and locally made products. At the community level, actions may include land use planning laws that discourage "urban sprawl" development patterns and make the area more pedestrian- and cyclist-friendly; more

[104] "Fairbanks Energy: Strategic Business Plan," published by the Fairbanks Economic Development Corporation in November 2007: http://investfairbanks.com/documents/FairbanksEnergy2.pdf.

stringent building codes to encourage the construction of more energy-efficient houses and offices[105] and the adoption of general energy efficiency standards; expanded public transit options; and a school curriculum that incorporates energy and environmental issues at all levels. The enormous challenge of climate change can be addressed not only by top-down policy and technological development, but also from the bottom up by some (usually modest) sacrifices on the part of individuals and communities.

R&D- Community leaders need to perform research about the current level of awareness and receptiveness to energy conservation measures among their constituents before making any sort of broad future plans. Residents of the Arctic are probably more aware of energy issues than average because costs are usually so far above average, and this presents the opportunity to highlight the large potential cost savings to individuals and cities that energy conservation can provide. This research may then lead to the development of effective methods for educating citizens about energy use and related environmental issues.

Infrastructure Needs- Infrastructure to encourage energy conservation should begin with the establishment of a dedicated group of community members who will focus on the issue. Information should be gathered into one central location where citizens can access it, but should also be disseminated in whatever way is deemed most effective—whether by town meetings, media outlets like pamphlets and newspapers and television, or through the schools. School curriculums should include energy education.

Implementation Costs- These vary greatly depending on the measures taken. Individual choices cost nothing. Consumer choices like efficient appliances can be expensive, but often return the investment within a short period of time. Community planning choices like land use reform only incur costs in the sense of requiring planners to discard old habits. Changes in building codes and school curriculum do entail real costs, but these will almost certainly be balanced by the energy savings they bring, especially in the longer term.

Timescale- Many of the actions discussed here can be implemented immediately. Changes in community planning practices and education campaigns take longer to have an impact, but can always begin without much delay if the community demonstrates the political will to do so.

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[105] The U.S. Green Building Council's LEED standards provide the recognized benchmark for evaluating the efficiency and environmental impact of building practices. The USGBC is now running a pilot program for a rating system on a larger scale, the LEED for Neighborhood Development, and is expected to release the post-pilot rating system in 2009. See the USGBC website: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=148.

Federal Programs- Though the federal government does little to promote personal conservation measures, it does maintain programs like Energy STAR that help consumers to select energy-efficient appliances. The government usually allows individual states and communities to set their own policies with regard to conservation and planning.

Short- and Long-term Benefits- Personal conservation and efficiency measures, when combined with larger community action, have the potential for significant cost savings in the short term, beginning almost immediately, and can also bring lasting long-term benefits. Present investments in education of citizens and in community planning practices may not only lead to cost savings in the future, but may make the area attractive to new residents. Many of the fastest-growing and most attractive cities in the U.S. have invested in public transit and made commitments to sound planning, responsible energy use and environmental protection. And initiatives at the state and national level can always aid local communities in developing and implementing energy plans and better planning practices.

b) "Smart Grid" Technologies

The term "smart grid" refers to a wide range of technologies that allow for an exchange of information between utilities and customers about electricity rates and usage, and also enable the utility to more actively manage load on the grid by reducing demand at peak load times and decreasing supply at off-peak times. They create significant cost savings for both customers and suppliers, increase the efficiency and security of the grid, reduce the frequency and length of blackouts and other disturbances, and delay the need for additions in both generating and transmission capacities.

A recent test program in the state of Washington demonstrated that when 112 households were given real-time information about electricity and heating use, and were allowed to pre-set their preferences, they achieved average cost (and energy) savings of 10% over the course of a year, and some significantly more. Such savings can reduce utility peak loads by up to 15%.[106] A Danish company has introduced a product called the "Electronic Housekeeper," and claims that it can reduce household energy bills by up to half; it is, however, still quite expensive.[107] Though such systems are not likely to become common in every household very soon, they show that consumers will conserve if given better information about energy use and prices. Such technology could be very effective in both urban and rural areas of the

[106] Lohr, Steve, "Digital Tools Help Customers Save Energy, Study Finds," from New York Times (1/10/2008): http://www.nytimes.com/2008/01/10/technology/10energy.html?ref=business.

[107] "Using a computerised monitor can help reduce electricity usage in the home during the hours when energy is at its most expensive," from Copenhagen Post (8/10/2007): http://www.cphpost.dk/get/103798.html.

Arctic, given high energy prices. A program of prepay metering systems in 21 small rural villages in Alaska has shown that customers will conserve when given sufficient information. A survey of customers using such a system on St. George Island in the Bering Sea found that 100% were conserving energy as a result, 100% were satisfied with the service, and that demand at the local power plant decreased.[108] Thus, while many of the more sophisticated supply-side "smart grid" technologies may not be cost-effective in the relatively small market of Alaska, some demand-side technologies may be well worth the investment.

R&D- Most of the smart grid tools applicable to Alaska and other Arctic regions appear to be well-developed at this point. But extensive development is still needed for utility management systems that incorporate energy storage mechanisms and integrate "distributed generation"—local renewable sources, local combined heat and power sources, etc.—into existing grids.

Infrastructure Needs- The wide application of smart grid technology requires a substantial deployment of technologies like prepay meter systems, and also the training of personnel to both install and monitor the systems. These systems are usually designed to be integrated with existing power generation configurations, so additional upgrades to generation equipment are not necessary.

Implementation Costs- Initial costs can be high for these smart grid technologies—the prepay meter systems installed in St. George cost $1,109 per household (which is actually less than the average annual household utility bill on the island), in addition to a community-wide start-up cost of about $12,000.[109] However, in many cases they can create substantial cost savings, and also increase the reliability of payment by customers in rural areas.

Timescale- Because most of the technologies exist today, funding is the main limiting factor for the implementation of smart grid systems.

Federal Programs- DOE's Office of Electricity Delivery and Energy Reliability coordinates many of the federal research and development activities surrounding smart grid technology. The goals set out in the

[108] Mike Brubaker presentation at AESTC, "Prepay Utility Meter Systems: A Case Study from the Aleut Region": https://www.confmanager.com/communities/c680/files/hidden/Presentations/Rur-10_Utility_Meters_Rural_AK.pdf.
[109] Mike Brubaker presentation

Office's 2007 Strategic Plan[110] will likely have limited impact in the Arctic. The CCTP outlines the research goal of testing a full prototype smart grid system somewhere in the U.S. by 2010.[111] Some Arctic communities, however, may be able to apply for federal infrastructure grants in order to fund smart grid technology implementation.

Short- and Long-term Benefits- Cost savings and improvements in electricity service are the primary quantifiable short-term benefits of smart grid technology. Over time, by allowing utilities to manage load so as to increase efficiency, the energy savings can reduce the need for new infrastructure like power plants and transmission lines, and thus contribute even more significantly to curbing carbon emissions. Perhaps just as importantly, though, smart grid systems promote awareness of energy use and encourage energy conservation by consumers, which can have long-term benefits that exceed mere cost savings.

c) Combined Heat and Power Systems

Combined heat and power (CHP) systems use a single energy source in order to produce both electric power and heat. They are usually envisioned as a localized energy source for a single building or small community with district heating, and come in a variety of designs that utilize a wide range of possible fuels: natural gas, solid biomass material, biogas (e.g. landfill gas), coal, oil and waste heat. Essentially, they are not a single technology but rather a general form of integrated energy system that can be adapted to the needs of the user. Their main benefit is an increase in energy efficiency. First, since they produce energy locally, they eliminate the need for transmission capacity and thus save the energy dissipated over long-distance electric lines. Second, they produce more energy per unit of fuel input than traditional systems, because they take advantage of excess heat. The average power plant in the U.S. converts only about a third of its fuel into usable electricity and expels the rest as heat, while a CHP system can convert 70% or more of the fuel into usable electricity and heat.[112] CHP can largely insulate a facility from the danger of large-scale grid blackouts, and any excess electricity not used locally can be sold back to the grid. Two main types of CHP exist—the gas turbine or reciprocating engine with a heat recovery unit, and the steam boiler with a steam turbine.

[110] *Transforming Electricity Delivery*, the Strategic Plan for the Research and Development Division of the Office of Electricity Delivery and Energy Reliability, September 2007: http://www.oe.energy.gov/DocumentsandMedia/RD_Strategic_Plan_Final07.pdf.
[111] *U.S. Climate Change Technology Program Strategic Plan 2006*, p. 76.
[112] *U.S. Climate Change Technology Program Strategic Plan 2006*, p. 76.

The second type operates by using solid biomass material or coal to run a boiler, which heats water into steam. This steam powers a turbine that produces electricity, and can then be used for heating or cooling instead of being lost. This type is more suited for industrial facilities that can keep a stock of solid fuel for the boiler.[114]

In the rural Arctic, the idea of cogeneration of power and heat may find another form: the use of a heat recovery system connected to a diesel generator. Diesel generators waste roughly 30% of the energy in diesel fuel as excess heat, and so, especially given the high energy prices and reliance on diesel for power in most rural Alaskan communities, this technology could significantly increase energy efficiency and reduce diesel demand. Moreover, it is flexible, in that it could be coupled with a variety of heating needs, including space and community water loop heating, desalination, thermal electric conversion, heat to power conversion, and heat for refrigeration and air conditioning. A group of engineers at UAF recently designed and tested such a system in the laboratory and found that it worked well—the system performed reliably over one year, did not affect the operation of the diesel generator itself, had no corrosion problems, and had low levels of soot deposits. The team estimated that the heat recovery system would pay for itself in cost savings within three to four years, though this would depend on particular circumstances. They also proposed that such a heat recovery system may become more cost-effective as ultra-low sulfur diesel (which is less corrosive than normal diesel and better suited to heat recovery) becomes standard by 2011. Though they cautioned that further testing is needed and each community should evaluate the use of heat recovery individually, such a system shows promise for increasing the efficiency of diesel use, which could have a major impact on energy costs in the Arctic over time.[115]

R&D- In order to maximize the efficiency of CHP mechanisms further technological development is needed, although high-performing systems are currently in use. These needs vary depending on the type of CHP system under consideration, but at present most consist of incremental improvements in efficiency and not basic advances in science or technology. Further testing and actual demonstration projects are necessary for diesel generator heat recovery systems.

Infrastructure Needs- A CHP system requires a fuel source and a building to which it will provide energy. If a CHP system is to be installed in an existing facility, the optimal type of system will largely

[114] U.S. EPA CHP Partnership website

[115] UAF presentation at AESTC, "The Selection and Design of an Exhaust Heat Recovery Application for Diesel Generators Used in Alaskan Villages": https://www.confmanager.com/communities/c680/files/hidden/Presentations/Rur-06_Heat_Recovery_Diesel_Generators.pdf.

depend on the type of fuel available and the cost of integrating the system into the facility. In this case, the pre-existing infrastructure will, for the most part, determine how a CHP system is implemented, and little extra infrastructure will be required. If a CHP system is incorporated into the design of a new building, this will reduce the cost of integrating CHP and also allow flexibility in choosing the types of system and fuel used; in other words, the infrastructure of the building can be designed around or in combination with a CHP system. CHP systems can provide great efficiency gains, but their full benefit cannot be realized without the larger-scale implementation of the "smart grid" systems discussed above, which will allow excess power from CHP to be sold back to the grid. Thus, especially in the longer term, "smart grid" technology is one of the most important infrastructure needs for CHP systems.

Implementation Costs- Initial costs can be high, but even very high costs can be repaid if the CHP system installed is particularly efficient within its specific context. The U.S. EPA CHP Partnership estimates that CHP may be a good option for buildings that pay more than $0.07 per kilowatt-hour, given a capital cost of $1,200 per kilowatt capacity installed.[116] Initial installation costs may be significantly higher in Arctic locations, but the corresponding higher price of energy may mean that CHP is a cost-effective option for many Arctic buildings and communities. Feasibility for CHP always varies greatly depending on circumstances. In the case of biomass- or biogas-fueled CHP systems, various funding opportunities and tax incentives may be accessible that can make a marginal project economical. The Cold Climate Housing Research Center (CCHRC) in Fairbanks, Alaska is currently testing a biomass-fired CHP system as a supplement to solar power in its Hybrid-Micro Energy Project.[117]

Feedback- CHP systems do emit carbon, although the amount varies based on the fuel used in the system. Natural gas emits less than oil, which emits less than coal. Biomass may emit even less than natural gas. Still, they are a great improvement over conventional fossil fuel power plants because they generate much more usable energy per unit of fuel.

Timescale- The technology exists today and is used in a wide variety of situations. Funding, along with interest in the technology, remain the limiting factors to its further deployment.

Federal Programs- CHP technology is coordinated largely through the Environmental Protection Agency's (EPA) CHP Partnership, a voluntary program that brings together the CHP industry, state and local governments, and possible CHP users, and is aimed at coordinating CHP development projects and

[116] See the U.S. EPA CHP Partnership website: http://www.epa.gov/chp/.
[117] See the CCHRC website: http://www.cchrc.org/research.html.

promoting the environmental and energy-efficiency benefits of CHP technology.[118] The CCTP highlights CHP as one of the forms of "distributed generation" that will help to modernize and strengthen the nation's electricity infrastructure, and aims to make a wide array of CHP technologies cost-effective and to promote their widespread adoption by 2015.[119] A study by DOE's Federal Energy Management Program (FEMP) found that a significant number of federal facilities in the state of Alaska could achieve energy cost savings if they installed CHP systems,[120] indicating that a large number of non-federal facilities might benefit from CHP as well. Beyond energy savings, biomass and biogas projects qualify for a federal PTC that greatly enhances their feasibility in many cases.

Short- and Long-term Benefits- CHP promises significant short- and long-term benefits, primarily in the form of greater energy efficiency, which brings both short-term cost savings and long-term reductions in carbon emissions. In the longer term, CHP can lead the move toward distributed generation, and, when integrated with "smart grid" technologies, eventually enhance the flexibility and resilience of the whole energy infrastructure. Moreover, the large-scale use of biomass and biogas as fuel will reduce emissions and dependence on fossil fuels while taking advantage of an energy source that would usually go to waste otherwise.

d) Building Design and Practices

A number of Arctic building experts, recently convened at the Sustainable Northern Shelter Forum in Fairbanks by CCHRC,[121] all agreed that a focus on the building "envelope" (the parts of the building that interface with the outside) is the most cost-effective way of reducing the energy usage of houses and commercial buildings, since a better envelope can not only reduce the amount of energy needed to maintain temperature, but also maintain temperature so well that smaller and simpler heating equipment can be used. The envelope includes the insulation in walls and floors and ceilings, the windows, and the entryways. The experts also agreed that there is a great need to design buildings (and, by extension, communities) holistically, rather than piece-by-piece, in order to achieve the greatest energy savings and simultaneously create livable spaces. The CCHRC Forum showed that a sharing of "best building practices" among Arctic nations is highly valuable and should be pursued further in the future.

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[118] U.S. EPA CHP Partnership website: http://www.epa.gov/chp/.
[119] *U.S. Climate Change Technology Program Strategic Plan 2006*, p. 76.
[120] FEMP Report "CHP Potential at Federal Sites": http://www1.eere.energy.gov/femp/pdfs/chp_execsumm_5-16.pdf.
[121] CCHRC website: http://www.cchrc.org/forum.html.

Holistic building design would include: siting and orienting a structure (preferably within the context of a well-planned community) so as to maximize passive solar gain via south-facing windows, minimize wind exposure, optimize landscaping and drainage, and maximize the potential for the use of small-scale renewable energy sources like solar and wind. It would also include the use of the least energy-intensive construction methods, the use of most environmentally-benign and least energy-intensive materials, and an emphasis on applying simple solutions—for instance, increasing insulation values rather than investing in a more complex heating system that will require more maintenance over the long term. In rural areas where indigenous peoples predominate, it is vital to include the input of tribal groups in the design process. CCHRC's newest project, begun in January 2008, is the construction of two practical and affordable rural Arctic homes that will demonstrate the best building design practices and materials available, maximize energy and water efficiency, and also incorporate the traditional knowledge of Alaska Natives for whom the houses will be built. This project will realize many of the goals and strategies emphasized at the Northern Sustainable Shelter Forum, and provide an important example for future rural Arctic construction.[122]

Given the large number of inefficient buildings currently in use, it is certainly not feasible to demolish all of them and completely rebuild. Incremental improvements and retrofitting, therefore, must play a large role in reducing energy use in Arctic structures. If they cannot include redesign of the whole building, these efforts should focus on insulation and energy-efficient appliances rather than more complicated technological solutions. Simple solutions are usually the cheapest and the easiest to maintain. CCHRC enjoys a large of amount of support from the building industry in Alaska, indicating that builders in Alaska, and throughout the Arctic, are concerned about energy use and willing to change old habits.

R&D- Building design and technology have made significant progress over the last few decades, and "net-zero-energy" buildings are now achievable, though they are expensive and require careful planning and implementation by knowledgeable architects and builders. Further research and development of materials and techniques is needed in order to make net-zero-energy buildings economical and to promote widespread adoption of the necessary building practices and materials.

Infrastructure Needs- There is considerable institutional inertia to be overcome in order to implement more efficient and sustainable building standards. First, building codes must be strengthened, and updated regularly, in order to keep pace with the development of better building techniques. Second, planners and architects and builders must be educated, and must communicate, about the industry "best

[122] See the CCHRC website: http://www.cchrc.org/research.html.

practices" so that they can be put into use as quickly as possible. If any of the three groups fails to adopt more energy-efficient goals and methods, the beneficial effect of the practices is weakened. Fortunately, the U.S. Green Building Council's LEED (Leadership in Energy and Environmental Design) standards provide a widely accepted benchmark for specific best practices, and only implementation lags behind. Widespread retrofitting will occur only after consumers are educated about the cost savings possible, but once this happens there will be a greater need for technicians, auditors, builders, etc. Community colleges and vocational-technical institutes in many cases provide the ideal place for such training.

Implementation Costs- Costs vary for retrofitting and energy-efficient building practices, but these actions will not be taken unless the extra initial investment is repaid within a specified period of time, though this period can vary from a few months to several years. In Alaska, the Alaska Housing Finance Corporation (AHFC) provides significant numbers of low-interest loans annually to homeowners who can benefit from better insulation, appliances, etc., and also to people buying a home that exceeds the Alaska Building Energy Efficiency Standard (BEES)—an important service in the Arctic.[123] As mentioned above, good building practices can have benefits beyond energy savings, because they can contribute to rendering a community more attractive as a whole and thereby increase quality of life and entice new residents and visitors.

Timescale- Though practices and materials are constantly improving, the knowledge and technology exist today to dramatically increase the efficiency and reduce the carbon footprint of new and old buildings. However, the construction of net-zero-energy buildings will likely not become common for perhaps two decades. Thus, it is vital that new buildings be held to a high energy efficiency standard and that retrofitting continue to improve the efficiency of old buildings.

Federal Programs- Though the federal government does not offer any Arctic-specific programs, it does support low-income weatherization programs and building research programs. In the CCTP, these programs include research in: integrated and "intelligent" building systems, building envelope, advanced energy-saving technology like "smart roofs" and on-site fuel cells, and better building design tools (e.g. computer software) that enable a holistic approach to design. It also funds the Energy STAR program, which awards a special label to electrical appliances that are especially efficient and seeks to encourage industry to develop more efficient models. The CCTP's stated goal for building efficiency is that net-zero energy systems be marketable for residential buildings by 2020, and for commercial buildings by 2025.[124]

[123] See AHFC website: http://www.ahfc.state.ak.us/energy/energy.cfm.
[124] *U.S. Climate Change Technology Program Strategic Plan 2006*, p. 64.

The recent Energy Security and Independence Act of 2007 mandated that all federal buildings reduce their energy use 30% by 2015, and that new or renovated federal buildings reduce fossil fuel use 55% by 2010 and eliminate fossil fuel use by 2030.[125] These ambitious targets and the high energy use per capita in Alaska provide an opportunity for the federal government to demonstrate its commitment by constructing a facility in a cold climate that uses no fossil fuels and shows high overall energy efficiency. Such a project would set a strong example for other federal and non-federal projects.

Short- and Long-term Benefits- In the short term, better buildings can provide the immediate benefit of energy efficiency and therefore cost savings and also expanded job opportunities in the building sector. But the implementation of better practices, more importantly, holds the promise of contributing to a general long-term commitment to sustainability and a less carbon-intensive lifestyle in the Arctic.

[125] EERE Network News (1/2/2008): http://www.eere.energy.gov/news/archive.cfm/pubDate=%7Bd%20%272008%2D01%2D02%27%7D.

5) Methane Hydrates and Carbon Capture and Storage

The extraction of methane hydrates and the use of carbon capture and storage (CCS) technology have both benefits and drawbacks. They allow humans to continue to use convenient fossil fuels while reducing carbon emissions, but they also prolong dependence on fossil fuels and contribute further emissions. However, since it currently appears that non-fossil energy sources will not be able to completely replace fossil sources in the short term, these two strategies may provide more time for the development of alternative energy sources and greater energy efficiency.

a) Methane Hydrates

Methane hydrates, found in large concentrations in the Arctic, are a fossil fuel, and their combustion entails all the GHG emission problems of fossil fuels. However, they represent an opportunity for the U.S. to continue using fossil fuels to buy time for the development of greater renewable energy capacity. Worldwide estimates of methane hydrate resources approach 400 million trillion cubic feet, with U.S. resources concentrated in the Gulf of Mexico and Alaskan Arctic and numbering between 113,000 and 676,000 trillion cubic feet.[126] Methane combustion produces significantly less carbon dioxide than combustions of other fossil fuels such as oil and coal,[127] and for every cubic foot of methane hydrate recovered, there can be up to 160 cubic feet of combustible methane recovered.[128]

Hydrates form under extremely low temperatures and pressures when gas molecules are surrounded by a cage of frozen water molecules known as a clathrate. When hydrates are extracted and burned, they resemble ice on fire. Hydrates also play a role in carbon capture and storage (CCS) technology, because captured carbon can form hydrates upon its injection into the ocean or ground, where it may be sequestered for a long period of time. Further discussion of this potential will occur in the section on CCS.

R&D- Current research and development on methane hydrates, under the aegis of the Department of Energy, focuses both on the Gulf of Mexico and Alaska's North Slope. A concern with methane hydrate research is the potential for blowouts, which can occur along shallow continental shelves such as that off of Alaska. Thus, while Alaska has far more methane hydrates off its shores, there is also more potential for them to erupt, cause shelf instability and waves, and emit methane. Research should focus on safely

[126] H.R. 1753 and S. 330, Methane Hydrate Research and Development Act of 1999. Hearing before the Subcommittee on Energy and Mineral Resources of the Committee on Resources House of Representatives, 25 May 1999.
[127] NRL press release on methane hydrates: http://www.nrl.navy.mil/pao/pressRelease.php?Y=2003&R=15-03r.
[128] Subcommittee hearing document.

harnessing this energy source while maintaining the stability and integrity of the coastal biogeochemical system; in this regard, the Messoyakha fields in Russia could prove to be a helpful precedent.[129] There is also interesting potential for hydrates' use in remote communities such as Barrow; development of such domestic use could demonstrate hydrate recovery along free gas/hydrate interfaces, a relatively new technology.[130]

While transport options have yet to be explored because of the early stage of hydrate surveying and recovery research, LNG transport may continue to be the best way of exporting this abundant methane source. Oak Ridge National Laboratory (ORNL) is currently conducting research on hydrate formation and dissociation using seafloor simulators that can help both to understand resource extraction and to enhance storage and transport.[131]

Infrastructure Needs- Infrastructure for the development of methane hydrates is already largely in place, due to oil drilling technology in the Arctic. If hydrate instability contributes to coastal erosion, however, physical infrastructure along the coast and for the hydrates' extraction must be strengthened. Moreover, stability research is worthwhile even if its ultimate goal is not hydrate extraction, since hydrate instability (with increased warming) can affect current oil and gas drilling infrastructure.

Implementation Costs- The implementation costs for the research and development and infrastructure necessary to extract methane hydrates are mostly associated with at-sea operations, because the resources are often located beneath the sea floor. DOE funding for natural gas hydrates R&D is $20 million for FY2007, growing by $10 million each year through FY2010; approximately 60% of this funding goes to public-private partnerships.[132]

Feedbacks- Feedback concerns for methane hydrates hinge not only on their status as fossil fuels—therefore as direct contributors, upon their combustion, to the GHG inventory and greenhouse feedback cycle of the atmosphere—but on the danger of blowouts. Research around the continental shelf of Norway has pointed to an ancient continental shelf slide, Storegga, caused by hydrate blowouts, which

[129] Timothy S. Collett and Gabriel D. Ginsberg, "Gas Hydrates in the Messoyakha Gas Field of the West Siberia Basin—A Reexamination of the Geologic Evidence", 1998: http://www.isope.org/publications/journals/ijope-8-1/abst-8-1-p022-JC-184-Collett.pdf.

[130] NETL "Fire in the Ice" methane hydrate newsletter, Spring/Summer 2007. http://www.netl.doe.gov/technologies/oil-gas/publications/Hydrates/Newsletter/HMNewsSpringSummer07.pdf

[131] Nucleation and dissociation of methane hydrates: http://sps.esd.ornl.gov/nucleationdissociation.html , also the ORNL's methane hydrate website at: www.ornl.gov/info/ornlreview/v33_2_00/methane.htm

[132] NETL ppt on challenges of commercializing methane hydrates: http://www.hartenergyconference.com/hydratemethane06/RBoswell.pdf

created a tsunami that slammed into the present-day British Isles and a period of increased warming.[133] Current seismic data along Alaska's northern coast could point to methane rumblings,[134] though the "clathrate gun" hypothesis so popular among doomsday proponents is highly unlikely.[135] (The clathrate gun theory states that recurring climate warming periods are due to sudden and massive hydrate blowouts.[136]) All blowout possibilities aside, methane hydrate extraction and combustion feedback cycles, as well as their negative consequences, are similar to those associated with any other fossil fuel.

Timescale- The Interagency Roadmap for Methane Hydrate Research and Development, released in July 2006 by DOE, aims to confirm the resource potential by 2010, with production potential by 2015 and large-scale Federal funding terminating in 2020, though the authors acknowledge that production could happen sooner because of demand.[137]

Short-term and Long-term Benefits- Methane hydrates can provide a cleaner-burning fossil fuel source while other mitigation technologies are developed, and should only be used to this end to reduce future warming. Because there are already government programs in place, with budget projections, and because the oil industry has already developed most of the necessary physical infrastructure, methane development is a feasible fuel source in the short-term. While there are large amounts of methane hydrates under the seafloor, they are still a fossil fuel and can contribute to severe global warming. If hydrates are used in the long-term, it is imperative that they be coupled with other mitigation technologies to reduce their detrimental effects on the climate.

b) Carbon Capture and Storage

Carbon capture and storage (CCS) technology is a short-term solution for carbon levels which can support existing infrastructure, and be a helpful addition to any mitigation portfolio. It is meant to accompany fossil-fuel energy production, and requires proximity to fuel production wells to be an effective strategy, so it could be appropriate for parts of the Arctic. CCS is the capture of emissions from conventional power plants or extraction sites, and their injection into the ocean or the ground for long-term storage.

[133] T. Bugge, R.H. Belderson, N.H. Kenyon, "The Storegga Slide", Phil. Trans. R. Soc. Lond.
[134] Phil McGillivary, personal correspondence, 26 July 2007.
[135] "Shooting Methane Blanks" (Science, 10 February 2003): www.sciencemag.org/cgi/reprint/311/5762/737e.pdf.
[136] Gerald R. Dickens, "A Methane Trigger for Rapid Warming?" (14 February 2003): www.sciencemag.org/cgi/reprint/299/5609/1017.pdf.
[137] "An Interagency Roadmap for Methane Hydrate Research and Development," from DOE Office of Fossil Energy, July 2006.

This ground storage can occur in exhausted oil wells, unmineable coal seams, or saline aquifers.[138] The carbon dioxide is collected for injection from production wells or power plants using technologies such as amine scrubbing. Unlike other mitigation schemes, it also offers an accurate measure of how much carbon dioxide is removed from the atmosphere, and what the cost of that removal is.

Globally, there are three main saline aquifer CCS development projects underway: in the Plains states in the U.S., in Germany, and in Norway's Sleipner oil field in the North Sea. The first successful saline aquifer injection field test, and an excellent example of CCS in the Arctic, Sleipner has been operational since 1996 and has sequestered over 7 million metric tons of carbon dioxide successfully.[139] Weyburn in the U.S. has been operating since 1999, and the CO2SINK project in Germany is just reaching operation.

R&D- Sleipner's development appears to have been paralleled by the development of relatively sound seismic sensing technologies, though leakage of sequestered carbon cannot be easily quantified.[140] Better monitoring systems are therefore a research need with CCS technology.

Regarding the CCS technology itself, however, more research is needed on the nature of clathrates: when carbon-based gases are injected deep underground or into the ocean, they form clathrates (like naturally-occurring methane hydrates), and the feedback cycles for clathrates are still poorly understood. This research might tie in with a methane hydrate R&D program.

Direct injection of carbon into the oceans can cause numerous environmental problems. It causes ocean acidification, in which dissociating carbon dioxide molecules increase the acidity of the water. This acidity affects the ecosystem at all levels, from weakening the carbonate exoskeletons of microorganisms to poisoning fish. Therefore, while research on the carbon "carrying capacity" of the ocean might seem worthwhile, because of the increasing amount of carbon in the atmosphere, the carrying capacity will likely be suppressed in the future. Saline aquifer storage appears to be a much better research investment.

Infrastructure Needs- Some of the infrastructure required for CCS already exists because of enhanced oil recovery systems—many fields have for years been the sites of CO_2 reinjection aimed at retrieving greater amounts of crude oil. Capturing technology is also needed, and transport will likely be the largest

[138] See the U.S. CCTP's Strategic Plan, Chapter 6, for a detailed description of coalbed and oil well sequestration: http://www.climatetechnology.gov/stratplan/final/CCTP-StratPlan-Ch06-Sep-2006.pdf.
[139] "CO2 Storage: Opportunities for the E&P Industry": http://www.pttc.org/technology_summaries/statev11no1.htm.
[140] IEA GHG R&D Program: www.co2captureandstorage.info.

infrastructure need for CCS, since the cost of the technology rises steeply as the distance between capture and storage sites increases.

Implementation costs- Carbon economics motivate project development: the chief motivation for beginning Sleipner's CO_2 injection was to avoid paying a carbon emissions tax,[141] and an increase in oil prices could stimulate additional enhanced oil recovery programs.[142] Ultimately, government regulation of carbon or an energy industry consensus on who will bear the cost of CCS will determine its future; currently, the start-up costs associated with the technology are too high to encourage its development.[143]

Geopolitical and Cultural Considerations- The London convention still protects the ocean from many of these technologies, most notably direct ocean injection, though its status with regards to the ocean floor may be changing.[144] Natural formations do not always respect political boundaries (for example, the Weyburn project in the Plains states actually transports carbon dioxide over the U.S.-Canadian border for storage), and both oceans and saline aquifers can cause international conflict when used for CCS. With current debate about the Arctic Ocean floor at the forefront of the political arena, injection could trigger some difficult disputes. The same goes for methane hydrate extraction. CCS technology will also likely meet with considerable opposition from environmental interests because it is largely untested in the long-term and works in conjunction with fossil fuel power sources.

Feedback- Of concern with CCS is the possibility that tons of trapped carbon dioxide will eventually escape. While large-scale CCS technology is in development, and scientists are fairly sure that carbon storage is permanent, only time will tell. Currently, it appears that while carbon and concrete react with brine in storage reservoirs, the means of storing the emissions underground are fairly stable. Studies of their long-term stability are essential, though, if this technology is to be developed further.[145] If CCS maintains its perceived degree of permanence, and research shows that this perception is correct, it should cause few feedback problems. Direct ocean injection causes feedback issues (by suppressing the carbon carrying capacity of the oceans), and hence is not an effective technology in the long term, though it

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141 "CO2 Storage: Opportunities" document, and Beverly Saylor, personal communication, 17 July 2007.
142 IEA GHG R&D Program website
143 "Incentives for CO2 Capture, Transport, and Storage": http://www.co2captureproject.org/news/documents/2007Updates/CCP2%20Principles%20CCS%20Incentives.pdf.
144 IEA GHG R&D Program: http://www.co2captureandstorage.info/docs/METI%20012007/Presentations_WS_on_CB/03_CCS%20status%20&%20confidence%20building%20Tokyo%20jan%202007.pdf.
145 Defigueiredo, Mark. "The Liability of CO2 Storage" (2007): http://esd.mit.edu/people/dissertations/defigueiredo_mark.pdf.

appears unlikely to generate a feedback that will cause the carbon stored in the deep ocean to well up on a near-future timescale.

Short- and Long-term Benefits- The short-term benefits of CCS technology are that it curbs emissions and can buy time for the development of long-term renewable energy options. It also prevents abandonment of current oil and gas industry infrastructure, while still enabling a shift to other forms of energy production. The long-term benefit of CCS is the flexibility of timescale it affords for the development of renewables.

6) Theoretical Geoengineering

While most geoengineering schemes are informal proposals that remain untested and unrefined, the creativity and scale of polar-specific geoengineering schemes makes them worthy of mention, if not further investigation. There are several types of proposed geoengineering. Some, such as iron fertilization and particulate expulsion, work directly with carbon. Others, like solar shielding, do not directly affect carbon levels. All of the schemes, since they are still purely speculative, would require enormous investments of capital and infrastructure, though they all promise immediate solutions to planetary warming through alteration of feedback cycles. If a state of environmental emergency occurs and geoengineering is the only way of preventing catastrophe, these immediate solutions may be more appropriate for the Arctic than for anywhere else because of the way that climate change is affecting the region drastically and swiftly (and because of the impact that Arctic systems, like sea-ice, have on the rest of the world's ecology). As Stanford scientist Ken Caldeira points out, however, many geoengineering schemes do nothing to lessen the amount of carbon in the atmosphere, but instead provide a cooling effect to buy time for other technological developments.[146] Even geoengineering champion and Nobel prize-winning chemist Paul Crutzen warns that geoengineering is a last-ditch attempt to save the Earth from catastrophic warming.[147] Geoengineering requires an understanding of total Earth systems that the scientific community will perhaps never achieve; any research towards geoengineering must be research toward understanding the effects of altering the climate drastically, rather than research toward understanding how to do so.

a) Solar Shielding

Solar shielding is a proposition for altering the albedo of the Earth by suspending sunshades in outer space or scattering sulfuric particles in the upper atmosphere.

R&D, Infrastructure Needs, Implementation Cost- Solar shielding takes the form of sunshades or stratospheric particulate infusion. Both projects are highly theoretical, so R&D needs cover every aspect of the project. In addition, while NASA likely has the rocket technology necessary to suspend millions of tiny sunshades at the inner LaGrange point, the sunshades themselves need to be built, in the range of a

[146] See Caldeira lab homepage for publications: http://globalecology.stanford.edu/DGE/CWDGE/home/main%20page/People/Caldeira/Caldeira_Research.php#_1

[147] "Albedo Enhancement By Stratospheric Sulfur Injections: a contribution to resolve a policy dilemma?" (Crutzen, 2006): www.springerlink.com/content/t1vn75m458373h63/fulltext.pdf

few trillion dollars.[148] Any particulate injection scheme, as well, would require infrastructure and research, and also be very expensive.

Geopolitical Considerations- The geopolitical considerations of solar shielding are enormous. Any solar shielding scheme would have to be an international undertaking, unless particulates were injected into the upper atmosphere on a very local level—something difficult to control. Doubtless, injecting particulates into the upper atmosphere could be misconceived as an act of aggression. While climate change is a global issue with global contributions, an international mitigation scheme to the extent of proposed solar shielding schemes would involve astonishingly complex negotiations. This is largely because the gains and losses resulting from this action would be unevenly distributed across the globe.

Feedback- Geoengineering directly impacts feedback cycles. Solar shielding would regulate incident light, affecting temperature and photosynthesis in the Arctic, among other systems. While suspended particulates would alter the albedo of the earth, their fallout might as well, in unpredictable and possibly detrimental ways. Lowell Wood[149] argues, however, that if the injection occurred at a high enough altitude this would not be the case, though there is no proof as to what outcome is likely.

Timescale, Short- and Long-term Benefits- The timescale for the development of solar shielding projects is on the order of a quarter-century[150], though their effects would be immediate. It is also unclear whether the effects of geoengineering are necessarily beneficial. There is no long-term aspect to geoengineering, save for the development of other mitigation technologies which might occur during an engineered period of cooling.

b) Expulsion of Particulates

Geoengineering schemes are usually the result of one man's musings; Al Wong, a UCLA physicist, is responsible for the idea to export carbon into outer space via the Van Allen belts. Because of the shape of the Earth's magnetosphere, the Arctic is the ideal launching spot for carbon. Current questions in the research and development of this idea hinge on energy efficiency and the feasibility of a heavy ion like CO_2 being catapulted into space—it may take more energy to export the carbon than would be mitigated. This technology has not been subject to pilot-project testing, and experimentation could prove overly expensive or harmful.

[148] "Solar Shield may save the planet": http://news.com.com/2300-11397_3-6132879-1.html.
[149] www.rollingstone.com/news/story/12343892/can_dr_evil_save_the_world/1
[150] "Solar Shield may save the planet"

c) Iron Fertilization

Iron fertilization refers to the dumping of iron sulfate into the ocean to increase plankton growth. It is designed to enhance algal blooms in nutrient-deficient waters. In theory, phytoplankton enhance the carbon sink of the world's oceans by taking up carbon dioxide during photosynthesis.

While the direct link between iron and plankton blooms has been well-established, there has been little large-scale experimentation, and that which has occurred points to iron fertilization being ineffective in the long term. The Southern Ocean Iron Fertilization Experiment (SOFeX) served as a good large-scale demonstration of the technology in the relatively barren Southern Ocean. However, a recent wealth of research shows that because of increasing atmospheric carbon levels, the carbon uptake of the ocean is affected regardless of the phytoplankton's contribution.[151] The potential of this technology in the Arctic is very little, despite the importance of sea-ice algae to the Northern ecosystem, says Dr. Josefino Comiso of NASA's Goddard Space Flight Center.[152] In addition, there is considerable international controversy over fertilization technology, given the London convention's prohibition on ocean dumping and the EPA's ongoing investigation of the California-based company Planktos' marketing of carbon credits in exchange for iron dumping. Because of iron fertilization's limited long-term effectiveness and potential harm to the environment, the low sequestration potential of the Arctic Ocean, and issues of legality, iron fertilization is an unattractive option for Arctic carbon mitigation research.

[151] http://daac.gsfc.nasa.gov/oceancolor/scifocus/oceanColor/iron_limits.shtml
[152] NIC and USARC Ice-Diminished Arctic conference poster abstract, and personal correspondence (7/16/2007).

Conclusion

This report began with the assertion that humans must take active steps to mitigate the effects of climate change. The length of the preceding sections is a testament to the fact that there is a lot happening in the Arctic right now—scientifically, technologically, socially and environmentally—and that the Arctic can indeed play a very important role in developing and implementing a coordinated and effective national policy for climate change mitigation.

The U.S. mitigation portfolio, it is now well-established, must tackle a multitude of challenges simultaneously. In order to achieve maximum impact, it must recognize the interconnections between issues and address them holistically. These interconnections can be glimpsed throughout this report: growing scientific knowledge of manmade climate change leads to research on natural carbon cycles, rising renewable energy production necessitates improvements in the existing fossil fuel-based grid infrastructure, increased need for energy efficiency prompts the development of better building and land use practices, and so on.

There is no longer any doubt that climate change, especially in the Arctic, will pose serious threats to the environment, human infrastructure, indigenous cultures, and to the carbon-intensive typical U.S. lifestyle. Responding productively and commensurately to the danger will require an unwavering commitment to broad policy initiatives, targeted technological and scientific advances, and personal- and community-level education and action, all while remaining focused on the greater purpose—leaving the best world possible for future generations.

Despite its reputation as distant and desolate, the Arctic is a region teeming with diverse ecosystems, complex natural cycles, significant resources, and vibrant human communities. This report has attempted to show that it is a region still poorly understood, but which simultaneously has a great impact on climate change throughout the rest of the world—on factors like sea levels, ocean currents, and the amount of carbon sequestered in plants and soils, to name a few. It is therefore vital that the future research projects listed below be given the proper priority.

Not merely a "canary in a coal mine," the Arctic promises to be a key site for investigating and testing a variety of carbon mitigation strategies, all of which may make a significant contribution to the "mitigation portfolio," and many of which could be adopted in other regions. As mentioned before, because of the unique conditions present in the Arctic, many of the strategies discussed here—geothermal power, wind-diesel hybrid systems, improvements in building design and practices, methane hydrate extraction, forest and peatland management, CCS systems, etc.—may become or already have become feasible in the Arctic earlier than elsewhere. For all these reasons, Arctic research deserves to be a central part of any national climate change mitigation strategy. And as the threat posed by climate change continues to grow, so will the importance of Arctic research.

Recommendations for Future Arctic Research Projects

What follows is a summary of recommended Arctic research projects that together have the potential to take advantage of the unique conditions in the Arctic while furthering the goals of climate change mitigation. For each of the six major areas discussed in the report, and for each subsection within those areas, a list of projects is given. Of course, all of these projects should be developed in the context of international partnerships and collaboration.

1) Monitoring

One of the first and most important steps in assembling a wise portfolio of Arctic carbon mitigation schemes is to develop a better understanding of the Arctic carbon cycle, of Earth systems, and of the likely consequences of future climatic changes. That broad goal will be supported by a number of specific studies.

i) Continued support of the AON and the integration of monitoring systems (as Australia is doing with its "Forest Network" project)

ii) Greater integration of high-resolution remote sensing systems and more widespread in-situ monitoring systems

iii) Research on nutrient (especially carbon and nitrogen) cycling in taiga and tundra ecosystems, as well as a more complete study of feedback systems

iv) Research on what receding ice means for algae and the Arctic food web, as well as for carbon storage

2) Fostering Carbon Sinks

Besides monitoring of environmental change in the Arctic, there is a great need for better understanding of carbon sinks and how humans can manage them and even enhance their absorption of carbon.

i) Study of Northern soils, forests and oceans to determine whether they are net sources or sinks of carbon, and how to shift the balance favorably

ii) Investigation of the implications of an advancing treeline and/or agricultural zone

iii) Use of geoengineering models to better understand Arctic feedback cycles

iv) Improvement of burn tactics and growth management systems for Northern forests

3) Modification of Point-Source Energy Production Methods

In order to become a less carbon-intensive society, it is vital that non-fossil energy production methods be developed and widely implemented. Many opportunities exist in the Arctic.

a) Geothermal Power

i) Further tests of advanced sensing systems for locating geothermal resources, and of improved exploratory drilling techniques

ii) Investigation of potential for local (off-grid) geothermal energy systems in the Arctic, similar to the one at Chena Hot Springs Resort

iii) Investigation of larger-scale, long-term EGS systems in the Arctic, perhaps coupled with carbon storage technology

b) Hydroelectric Power

i) Further studies of the feasibility of integrating micro-hydro projects with diesel generation in rural communities

ii) Development of methods for overcoming cold climate issues affecting Arctic micro-hydro projects

c) Wind Power

i) Development of energy storage mechanisms and turbine designs appropriate for Northern climates

ii) Refinement of reliable wind-diesel hybrid systems

iii) Development of local infrastructure for the manufacturing, distribution, installation, operation and maintenance of wind turbines in the Arctic

iv) Drafting and implementation of regional wind energy plans where they are beneficial

d) Solar Power

i) Investigation of solar power as part of a hybrid renewable energy system, such as the Hybrid Micro Energy Project at CCHRC in Fairbanks

ii) Development of solar water heaters and other energy-saving applications

e) Wave, Tidal and Osmotic Power

i) Establishment of research and development center for Arctic ocean energy projects

ii) Investigation of how to make wave energy development feasible in Alaska

iii) Aggressive pursuit of tidal energy development in Cook Inlet

iv) Preliminary study of possible osmotic power resources in Alaska

f) Biomass Power

i) Large-scale study of the feasibility in Alaska of biomass-fueled systems for electricity and heating (perhaps district heating)

ii) Testing of hybrid power generation, combining biomass and other renewable sources

iii) Demonstration of a large-scale biodiesel manufacturing facility in Alaska

iv) Investigation of further methods for extracting energy from municipal waste, especially those that could be cost-effective in smaller Arctic communities

g) Hydrogen and Fuel Cell Technology

i) Study of the feasibility of intermittent renewable power sources connected to hydrogen storage systems, with a demonstration project

ii) Investigation of the export of energy generated by renewable sources, using hydrogen

h) Nuclear Power

i) Careful observation of the Galena nuclear project's safety and cost-effectiveness

ii) Investigation of other suitable Arctic locations for small-scale nuclear power (if the Galena project is successful)

4) Energy Conservation and Efficiency Measures

Energy conservation and efficiency will be more important than ever as the Arctic and the world adapts to the challenges of climate change. Because of particularly high energy costs and awareness of the dependence on energy for survival in a harsh climate, the Arctic could well adopt many of these measures before other locations.

a) Personal Conservation and Efficiency, and Community Planning

i) Large-scale education campaigns about energy and the environment, the need for conservation and efficiency, and how to conserve

ii) Establishment of central information source where Arctic citizens can learn how to conserve

iii) Development and implementation of community energy plans in all Arctic communities

iv) Study of how to incentivize sustainable local policies (e.g. land use planning that discourages "sprawl" and highly energy-efficient building codes)

v) Study of the "best practices" from other Arctic nations

b) "Smart Grid"Technology

i) Investigation of the large-scale implementation of "smart grid" systems in the Arctic, particularly those that give consumers information about their energy use (e.g. prepay meter systems)

ii) Comprehensive study of the how to ensure that Arctic grids can successfully integrate new renewable energy projects and local CHP systems, including the need for energy storage mechanisms

c) Combined Heat and Power Systems

i) Large-scale study of the feasibility of biomass CHP for power generation, heating, and district heating in Alaska, perhaps combined with other renewable energy sources

ii) Demonstration of large- and small-scale CHP system applications in Arctic conditions, especially diesel engine heat recovery systems

d) Building Design and Practices

i) Central information source and standardized training program on sustainable building practices for Arctic planners, architects and builders

ii) Further demonstrations of energy-efficient, sustainable Arctic building designs, e.g. a federal facility that uses no fossil fuels and achieves net-zero energy use

iii) Research and development of better materials and construction equipment for Arctic structures—insulation, windows, etc.

iv) Investigation of effective methods for incorporating the input of indigenous peoples

v) Study of the "best practices" of, and cooperative demonstration projects with, other Arctic nations

5) Methane Hydrates and Carbon Capture and Storage Systems

Methane hydrates and carbon capture and storage systems take advantage of the existing oil and gas industry infrastructure, while reducing carbon emissions and allowing time to further develop less carbon-intensive forms of energy production, especially renewable sources.

a) Methane Hydrates

i) Further research on the stability of methane hydrates and their feasibility as a Northern energy source and as an export

ii) Study of the need for infrastructure strengthening in the Arctic because of methane hydrate instability and extraction

b) CCS Systems

i) Study of coupling CCS with existing Arctic production wells (because of the advantage of short distances for CO_2 transport)

ii) Research comparing the economics of CCS in the Arctic under either a carbon tax or a cap-and-trade scheme

iii) Demonstration of the long-term stability of underground carbon storage

6) Theoretical Geoengineering

Since geoengineering schemes are inherently uncertain and risky, and because they are only to be deployed in dire circumstances, large-scale testing appears to be unrealistic at this point. However, they do merit some further consideration.

i) Further study of the feasibility of solar shielding and expulsion of particulates

United States
Arctic Research Commission

July 23, 2008

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C.H. "Bud" Albright, Jr., Under Secretary
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Dear Bud,

Thank you and Doug for taking the time to meet with me while you were in Alaska. Barely 30 minutes after Senator Murkowski had told me you were in her office, we got together. That's fast work!

I write concerning the future of DOE's Arctic Energy Office. The U.S. Arctic Research Commission is a strong supporter of the program, which dates to 2001, as part of DOE's National Energy Technology Laboratory. Much of the Arctic Energy Office's work is paying off in facilitating greater fossil energy production in the U.S. Arctic. On behalf of the Commission, we urge the DOE to allow the Office to be able to support research activities in the areas of non-fossil fuels/alternative energy, in addition to its current focus on fossil fuels.

The Commission is seeking this change for several reasons. First, we believe DOE should be working all forms of energy development in the Arctic as part of an integrated program. Arctic residents must choose between all types of fuels and power sources to meet their needs. With hundreds of communities "off grid" in the U.S. Arctic, and – we are told – close to 2000 communities "off grid" in other parts of the Arctic, enabling appropriate choices for power and energy use will help these communities survive. Energy costs are much higher in this part of the world, and applied research on new techniques can have a faster, sustainable payoff for all Americans when Arctic communities are used as a laboratory.

Second, we believe research on all Arctic options can play an important and beneficial role to both energy security and reducing the world's carbon footprint. A new USGS review of Arctic oil and gas potential is soon to highlight this part of the world. Our hydro, wind, coal, geothermal, estuary/osmosis and wave energy potential is significant. Mother Nature has some of her biggest carbon sinks in the Arctic. New mitigation techniques may also take advantage of the Arctic's unique features, including cold ocean water, deep permafrost, gas reservoirs, or – as I mentioned when we met – the high-latitude magnetic features of the Earth.

There are several ways this objective might be reached. Ideally, as you and I discussed, the Office would report directly to the Office of the Secretary. (That approach, which we prefer, was contained in the draft colloquy I left behind with you, in language prepared for Congressional floor debate earlier this year.) Without an organization change, an order on your part could simply remove the fetters from the program. At the same time, you could direct the office to tie DOE's Arctic Research goals into the President's Climate Change Technology Program as well as the basic science being conducted by DOE in the Arctic as part of the Climate Change Science Program. The office might serve as a clearinghouse for funding research conducted by other laboratories of DOE, even as it keeps its funding base in fossil fuels.

Either of the latter two options could be announced by DOE alone, or perhaps brought about by agreement with the Commission and the Interagency Arctic Research Policy Committee. The Interagency Arctic Research Policy Committee is committed now to producing an Arctic research plan on infrastructure issues (including energy) throughout the government, per the Commission's recommendation, and the Arctic Energy Office would be an appropriate participant in that plan. Undersecretary Ray Orbach participated in the IARPC May 12 meeting at the National Science Foundation where the U.S. Army Corps of Engineers, Cold Regions Research Laboratory, announced it would take the lead in compiling that plan.

I am in Washington, DC on August 6 and could meet with you and others then if more discussion is needed to bring this change about. The Commission came to this recommendation from discussions we've had in many public meetings with Arctic scientists and residents alike. It is time to lift the limitations on this research program today.

With best regards,

Sincerely,

Mead Treadwell, Chair

Cc: via email, Doug Schwartz

The Under Secretary of Energy
Washington, DC 20585

October 31, 2008

Mr. Mead Treadwell
Chair
U.S. Arctic Research Commission
420 L Street, #315
Anchorage, AK 99501

Dear Mr. Treadwell:

Thank you for your July 23, 2008, letter regarding the Department of Energy (DOE) Arctic Energy Office (AEO). We appreciate the interest you, the United States Arctic Research Commission, and the State of Alaska have taken in this office.

I agree with your assessment that the AEO has made significant contributions in the area of fossil energy investigations and development. We fully intend to continue these efforts. At the same time, we share your concerns about the extreme costs for energy, particularly as it relates to remote Alaskan villages inhabited by native peoples. I have made a decision to immediately establish at least one more full-time position in Alaska to carry out an expanded mission for alternative energy. As we seek to fill this position, the Department will identify an expert from our National Renewable Energy Laboratory who will temporarily relocate to Alaska and make an initial assessment of the challenges and opportunities for deployment of energy efficiency and renewable energy technologies.

Thank you for your letter and your continued support for the AEO.

Sincerely,

C. H. Albright, Jr.

cc: The Honorable Lisa Murkowski
United States Senate
Washington, DC 20510-0203

RECD NOV 06 2008

The Secretary of Energy
Washington, D.C. 20585

October 23, 2008

The Honorable Lisa Murkowski
United States Senate
Washington, DC 20510-0203

Dear Senator Murkowski:

Thank you for your August 7, 2008, letter regarding the Department of Energy (DOE) Arctic Energy Office. We appreciate the interest you, the United States Arctic Research Commission, and the State of Alaska have taken in this office.

I agree with your assessment that the Arctic Energy Office has made significant contributions in the area of fossil energy investigations and development. We fully intend to continue these efforts. At the same time, we share your concerns about the extreme costs for energy, particularly as it relates to remote Alaskan villages inhabited by native peoples. In response to your letter, the Department is currently identifying an expert from our National Renewable Energy Laboratory who will temporarily relocate to Alaska and make an initial assessment of the challenges and opportunities for deployment of energy efficiency and renewable energy technologies. In the longer term, we plan to establish at least one more full-time position in Alaska to carry out an expanded mission for alternative energy.

Thank you for your support in solving energy issues for all Americans and for highlighting the opportunities for broadening the mission of the Arctic Energy Office. I look forward to working with you on this issue, and I will keep you apprised of DOE's efforts to maximize alternative energy development in Arctic climates.

If you require additional information, please contact me or Ms. Lisa E. Epifani, Assistant Secretary for Congressional and Intergovernmental Affairs, at (202) 586-5450.

Sincerely,

Samuel W. Bodman

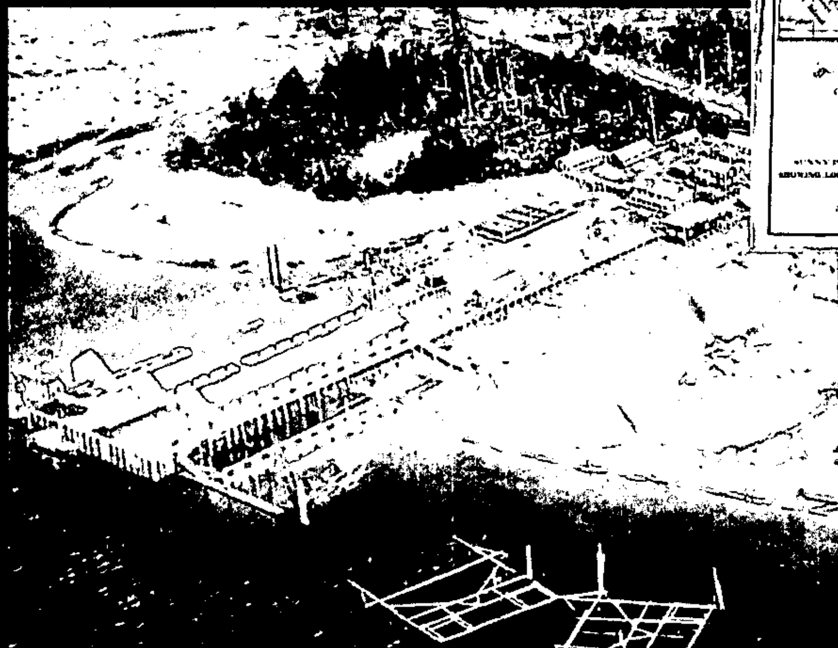
3-19-09 Overview: Ketchikan Shipyard

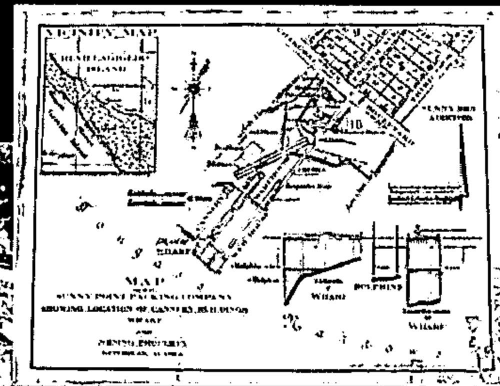
<target><bill></bill><subject>3-19-09 Overview Ketchikan Shipyard</subject><comm>SWTR26</comm></target>

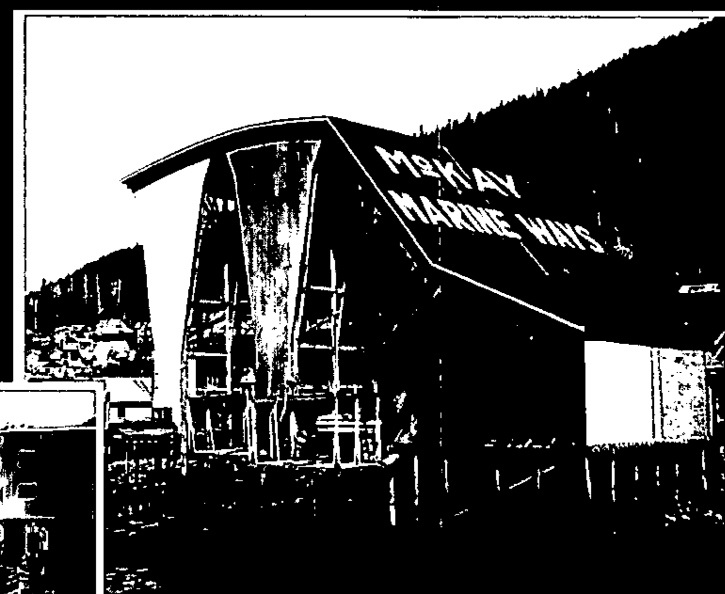
The Ketchikan Shipyard

A Public Private Partnership supporting the concurrent development of shipyard

- Infrastructure
- Market
- Workforce
- Creating Regional Competitive Advantage to Attract New Investment





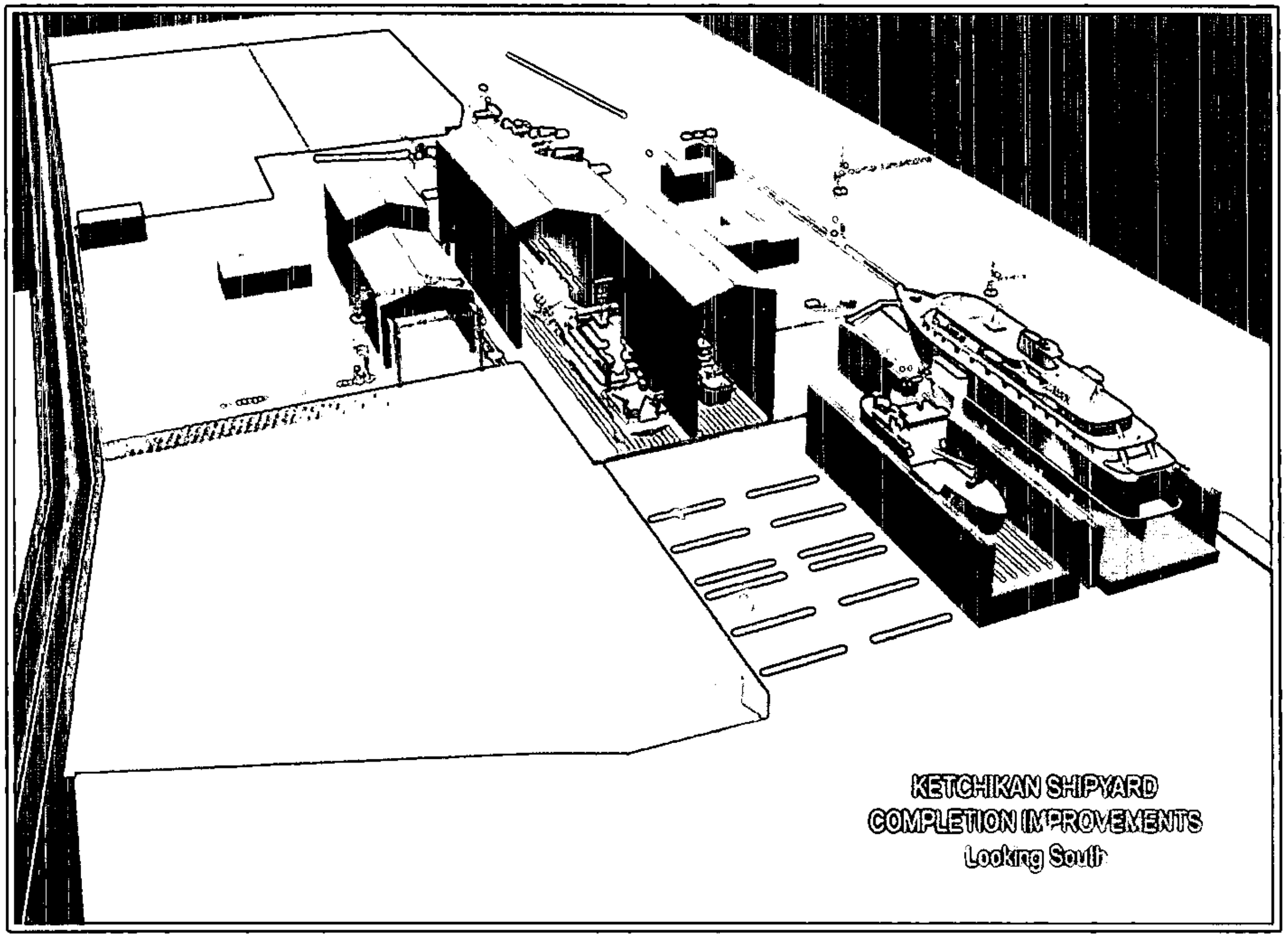


Early Shipyards in Ketchikan

1415


Ketchikan Shipyard
Established 1987

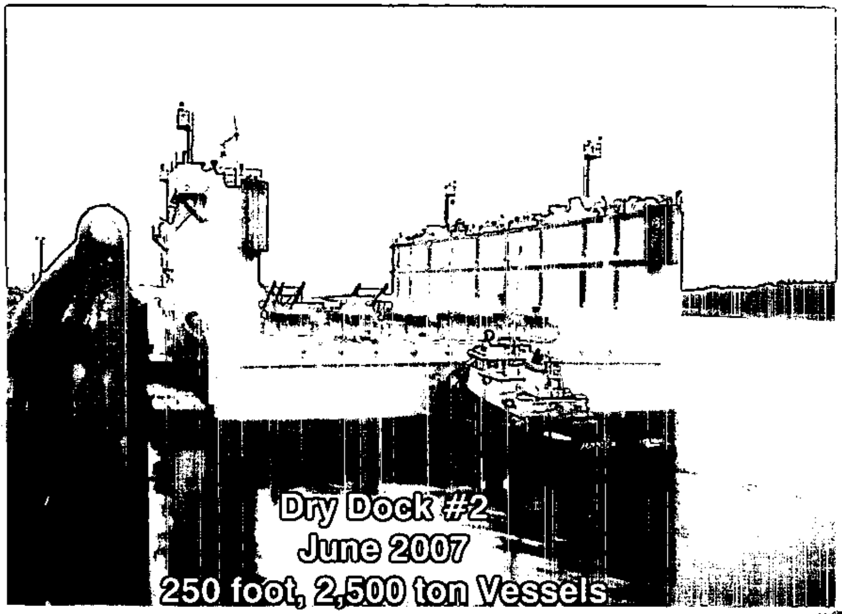
Ketchikan Shipyard Development Plan



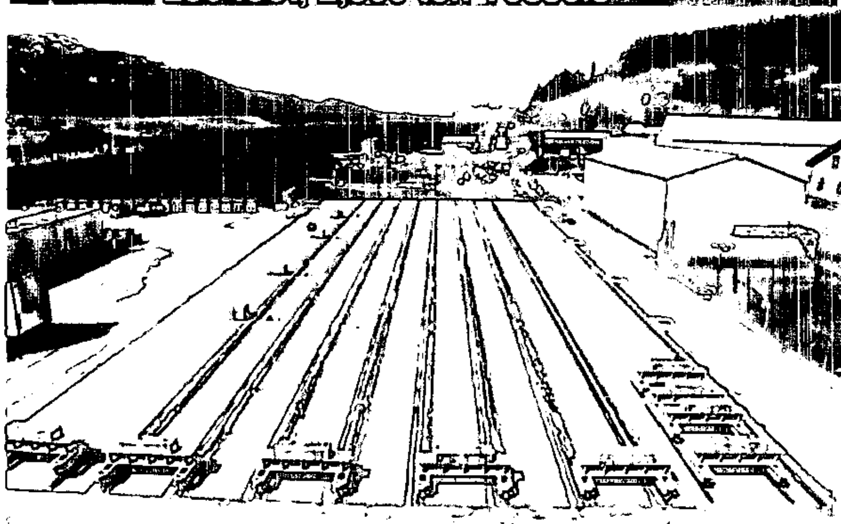
Ketchikan Shipyard

Expansion & Improvement

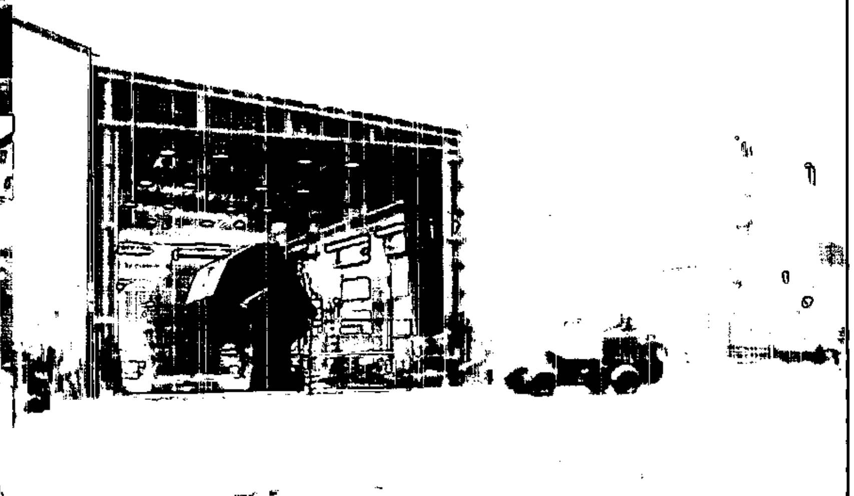
2007 & 2008



Dry Dock #2
June 2007
250 foot, 2,500 ton Vessels



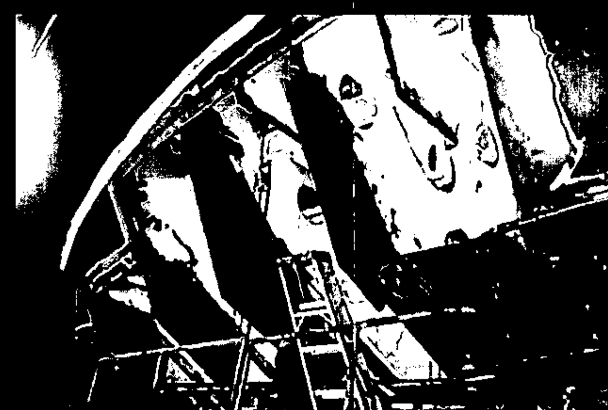
Berth #1 Land Level Berth
March 2008



Fabrication & Assembly Building
Fall 2007

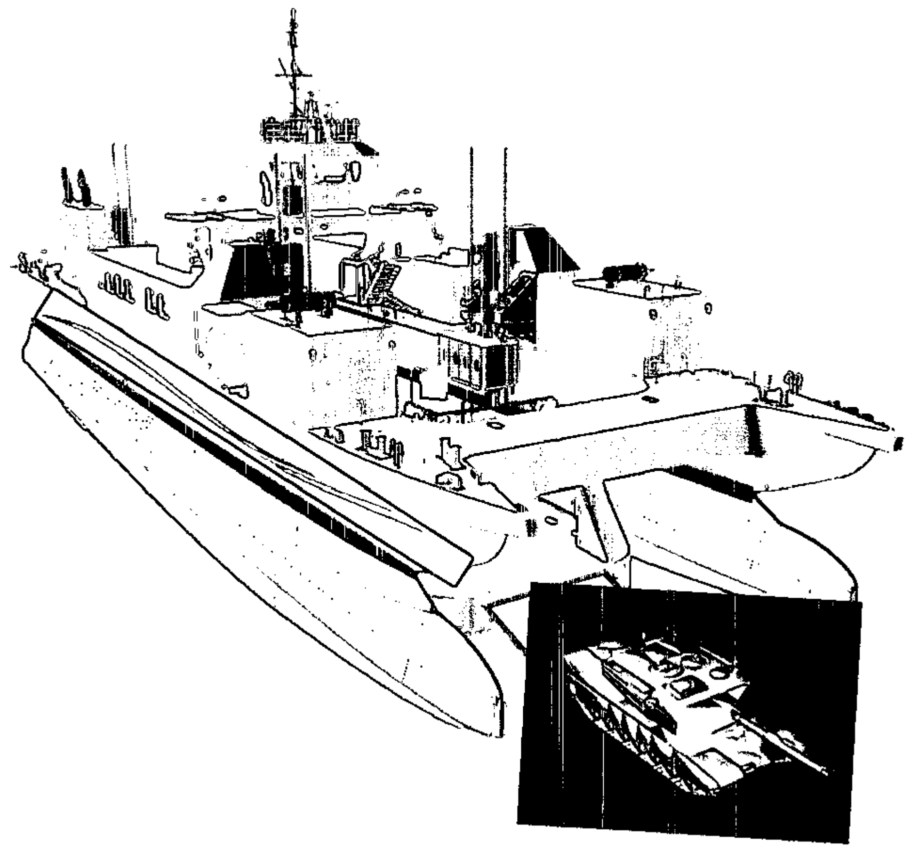
1419

Reducing the Cost of Operating Alaska's Marine Transit System



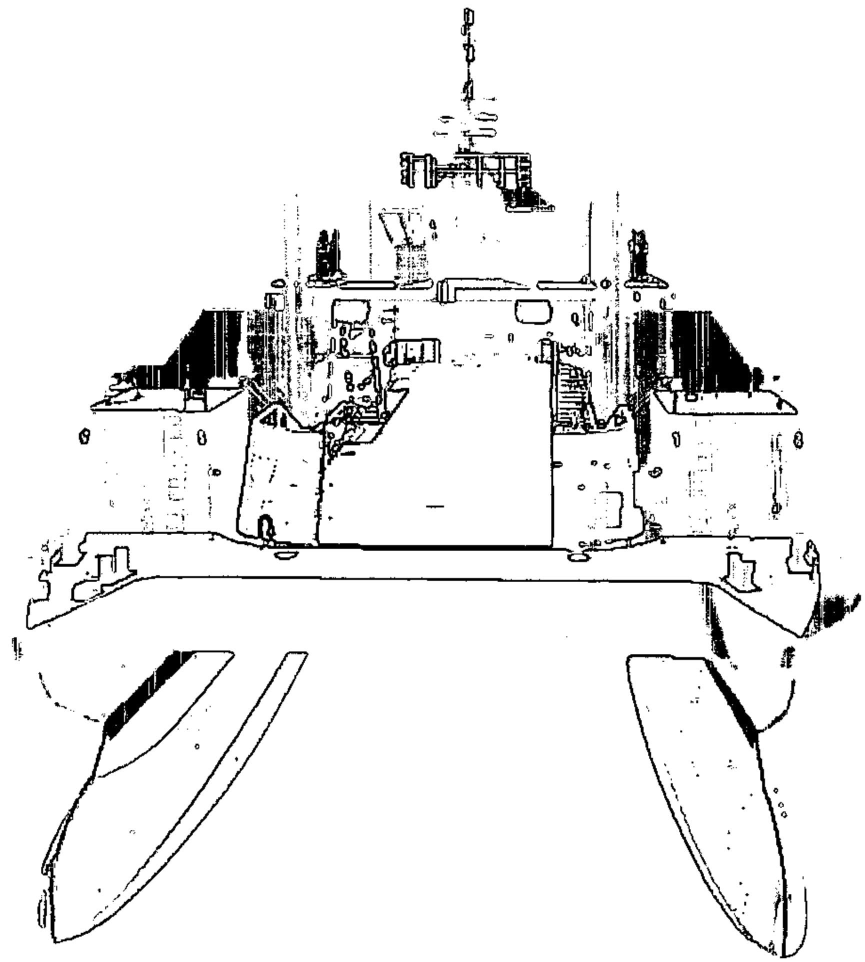
M/V Susitna

An Office of Naval Research Demonstrator Vessel owned by Mat/Su Borough to be operated as the world's first twin hulled, ice breaking ferry across Knick Arm

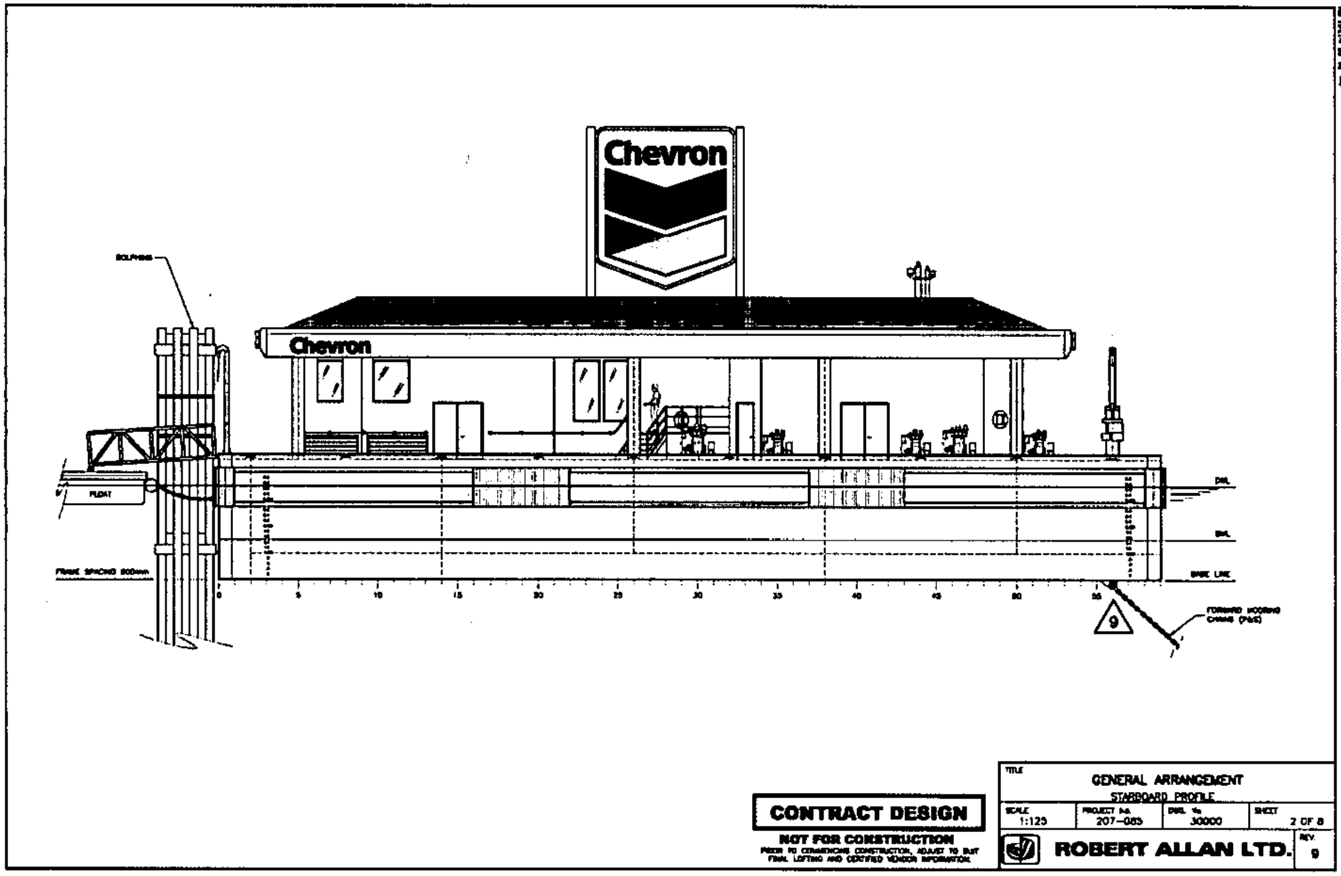


M/V Susitna

Cargo Deck in Raised Position for High Speed, High Sea States, Large Payloads over Long Distances

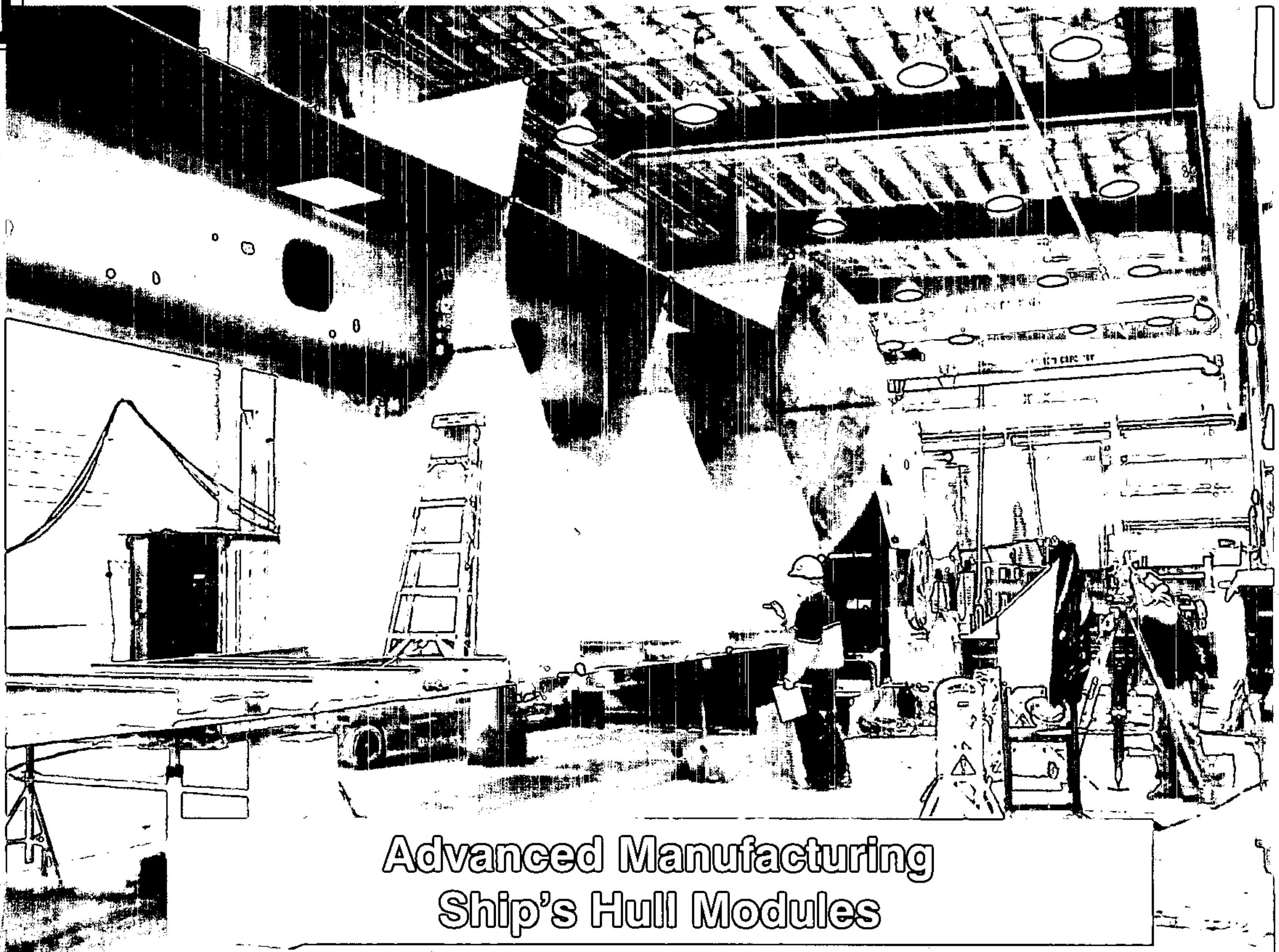


Chevron Coal Harbor Marine Fueling Station

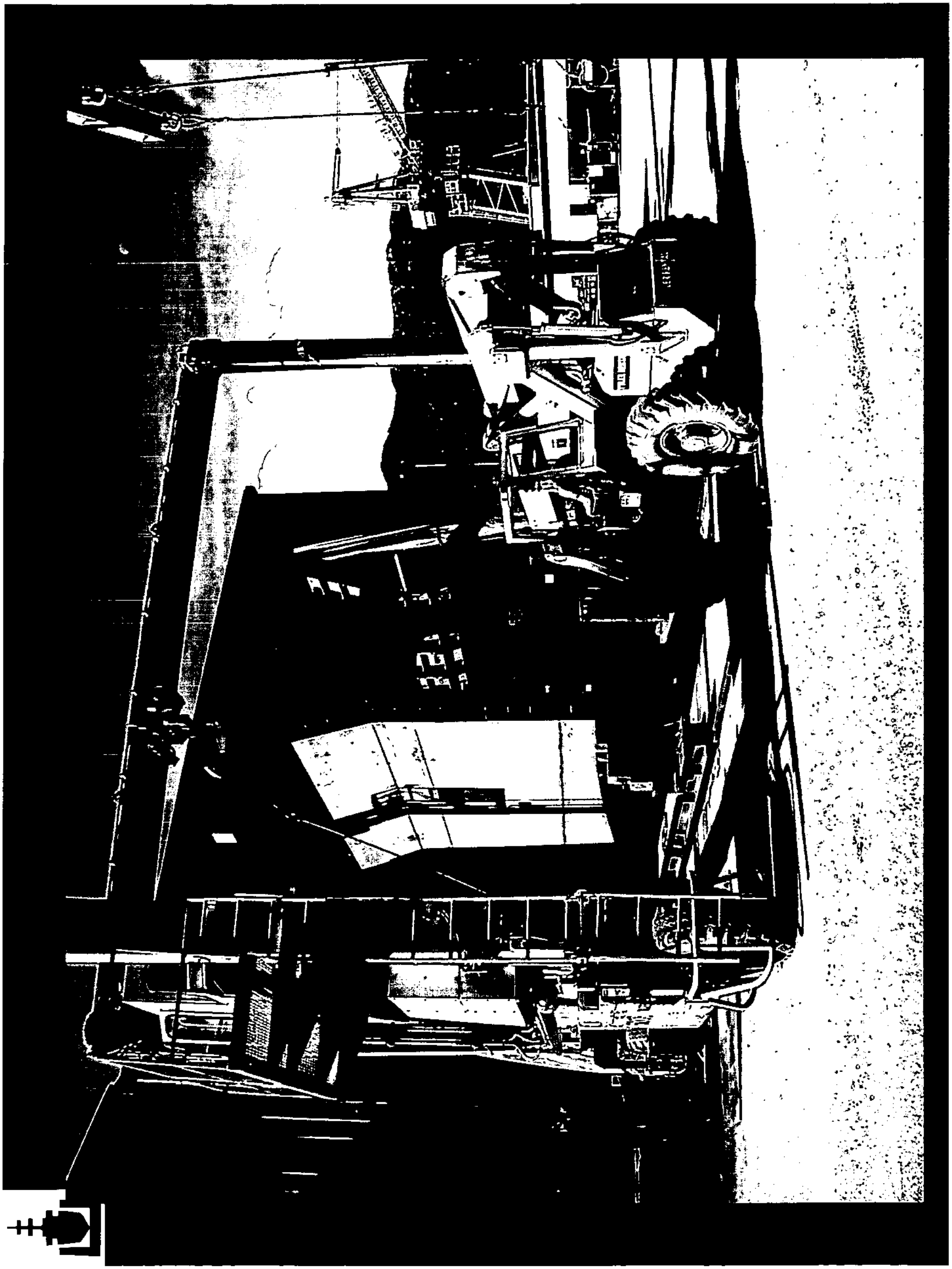


Advanced Manufacturing Practices

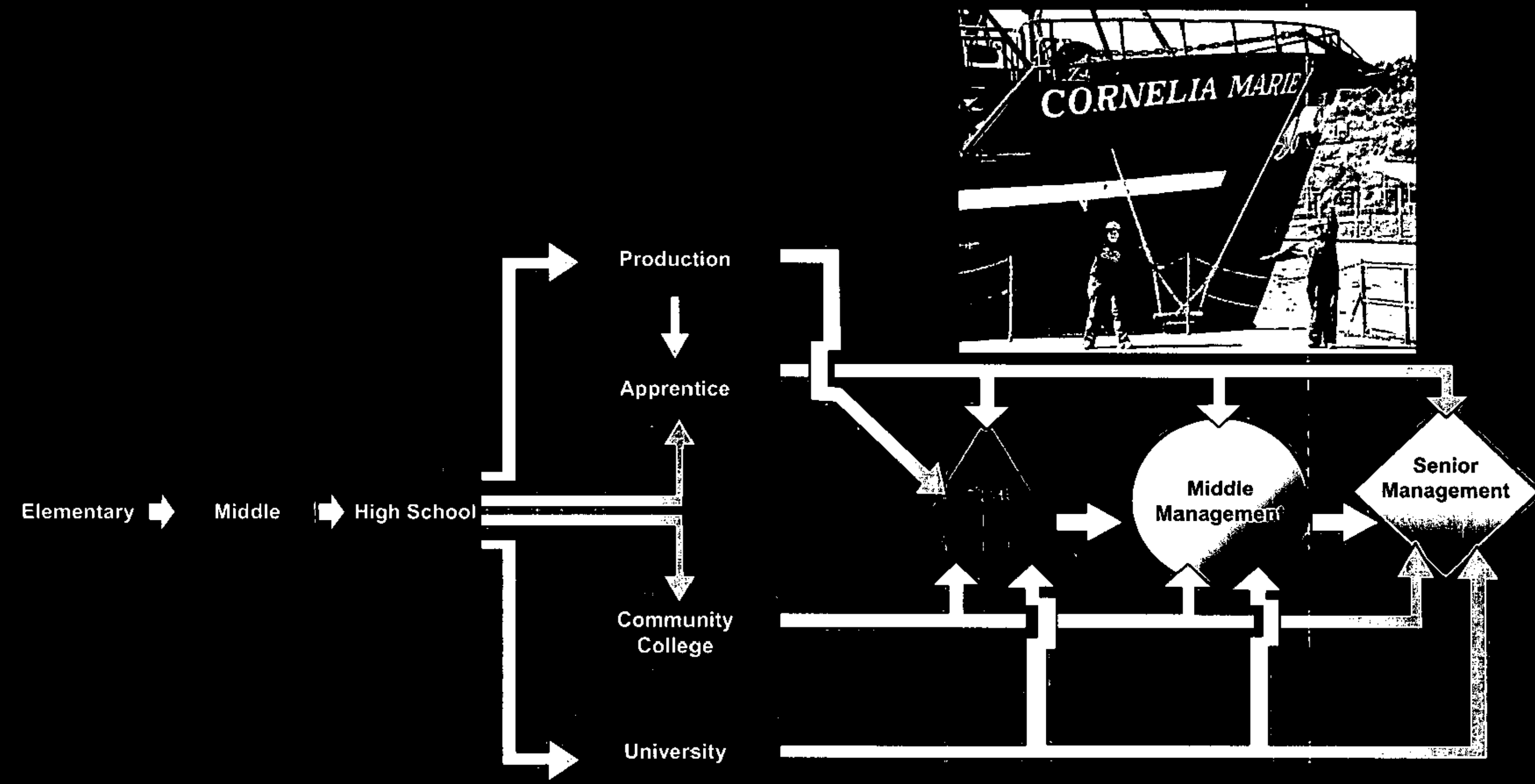
Ship's Hull Panels



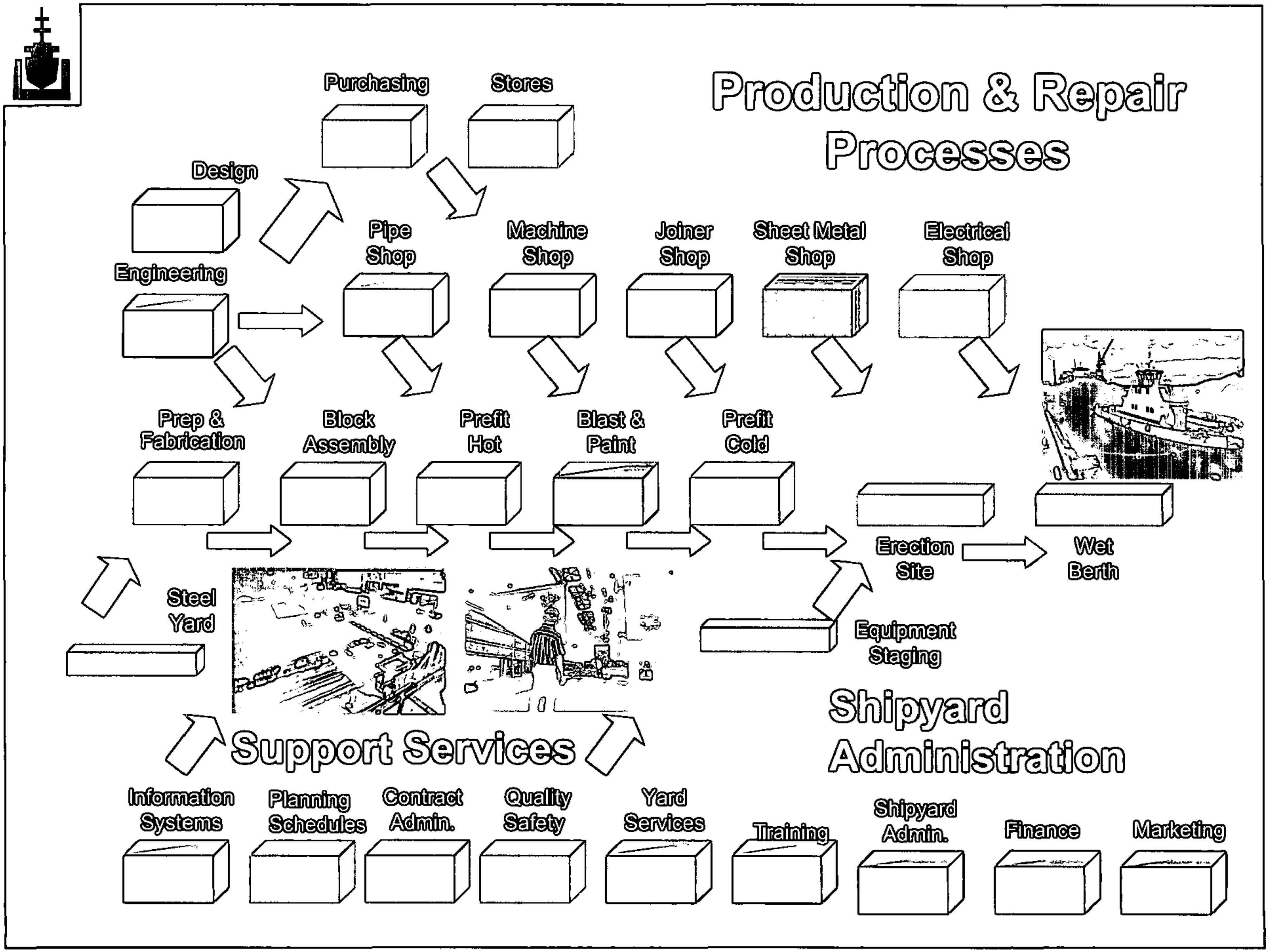
Advanced Manufacturing
Ship's Hull Modules



Shipyard Caree



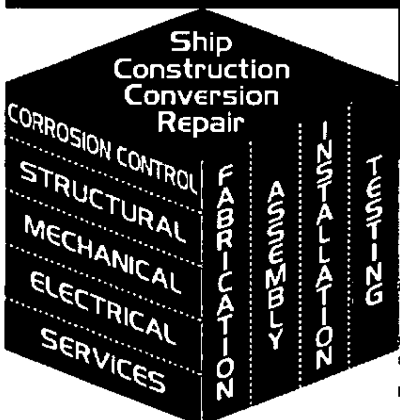
Career Pipelines -- Pre-Employment Assessments – Learning—On-The-Job Training

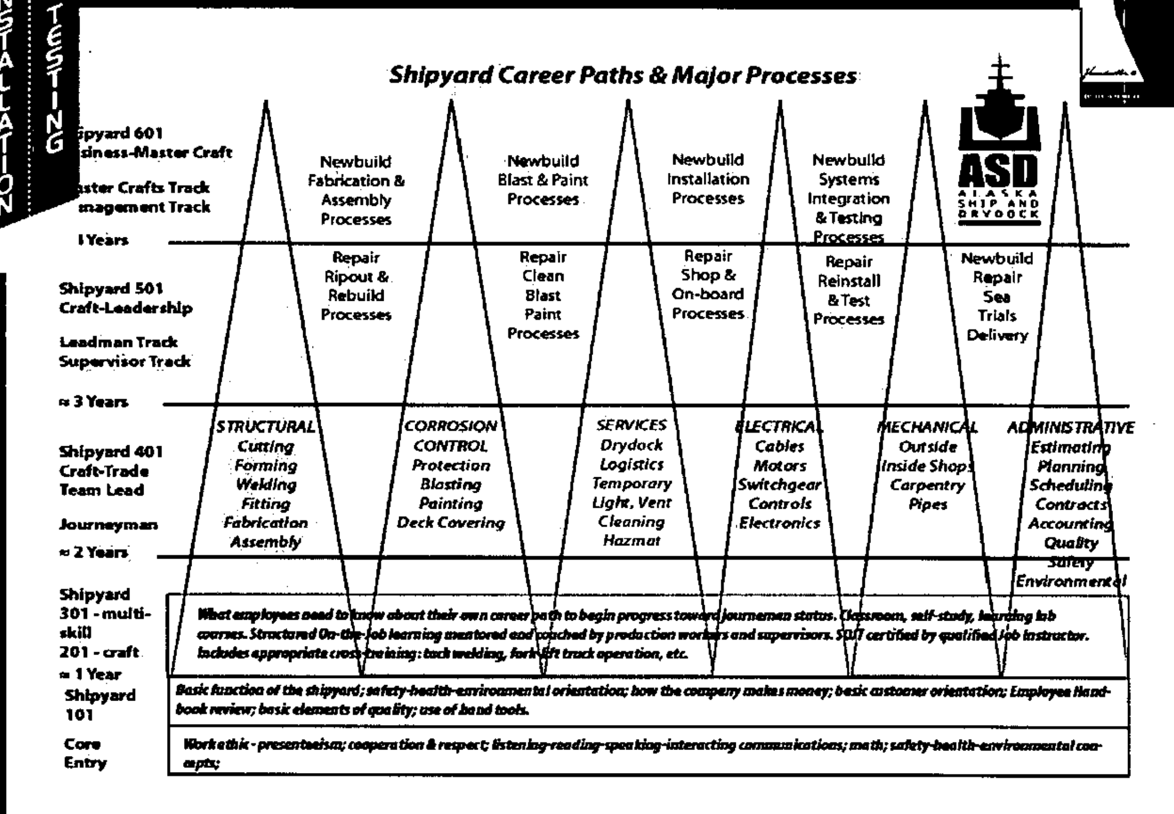


Production & Repair Processes
Purchasing
Stores
Design
Engineering
Pipe Shop
Machine Shop
Joiner Shop
Sheet Metal Shop
Electrical Shop
Prep & Fabrication
Block Assembly
Prefit Hot
Blast & Paint
Prefit Cold
Erection Site
Wet Berth
Steel Yard
Equipment Staging
Support Services
Shipyard Administration
Information Systems
Planning Schedules
Contract Admin.
Quality Safety
Yard Services
Training
Shipyard Admin.
Finance
Marketing

1428

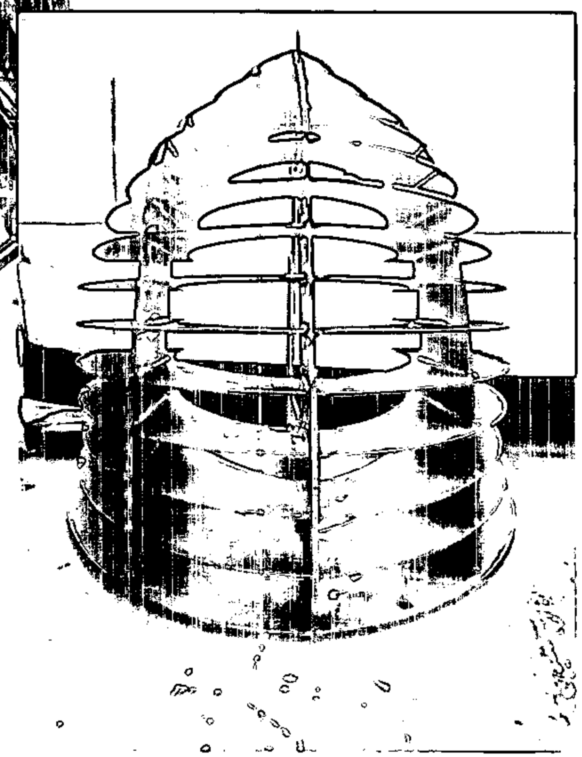
Multi-Skilled Shipyard Production Worker Apprenticeship Supported by Training Within Industry (TWI)





State Training & Employment Program

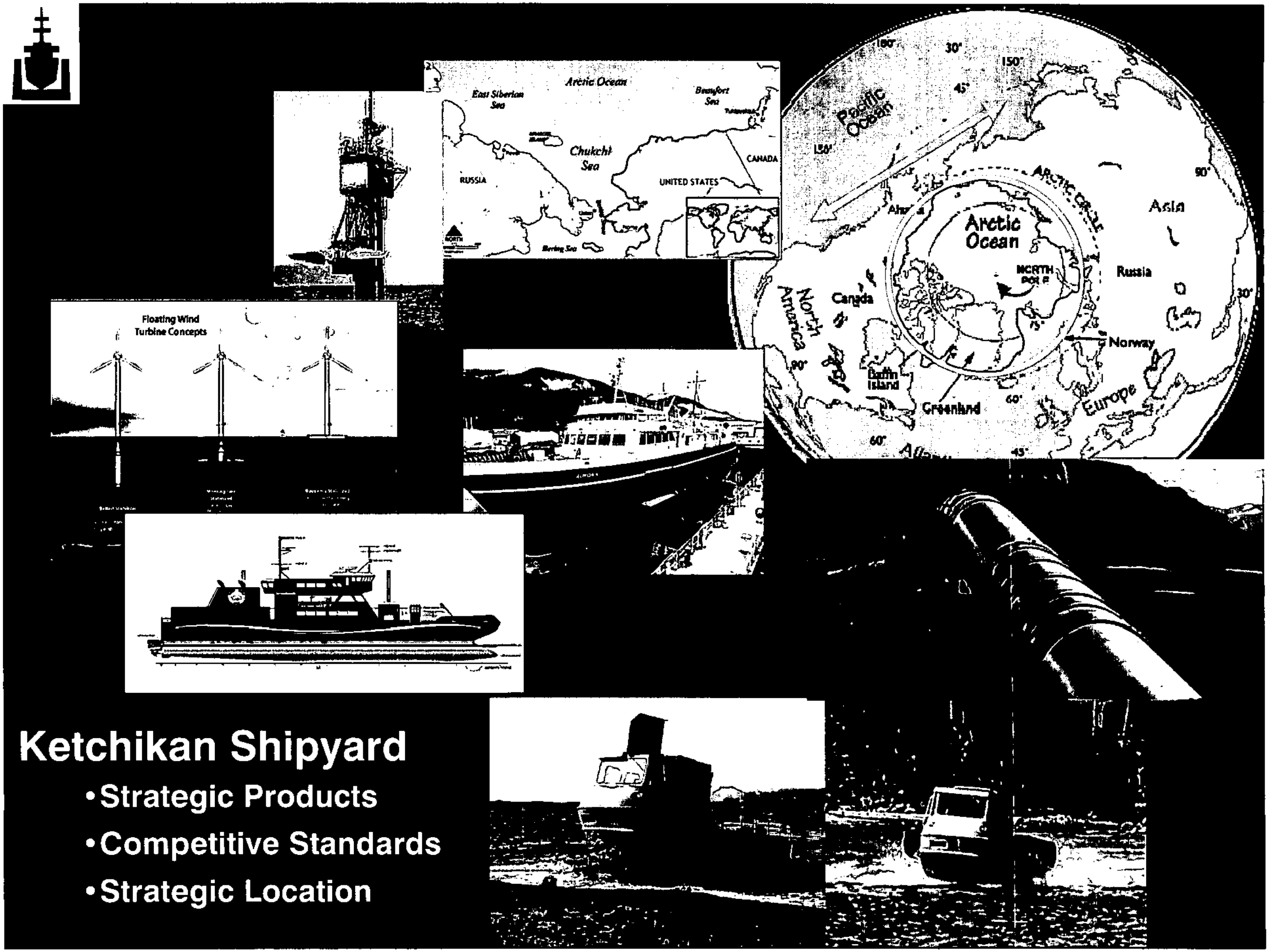
STEP
HB 105



Applying Training Within Industry Applying to construction of the M/V Susitna

Complex Fabrication & Assembly

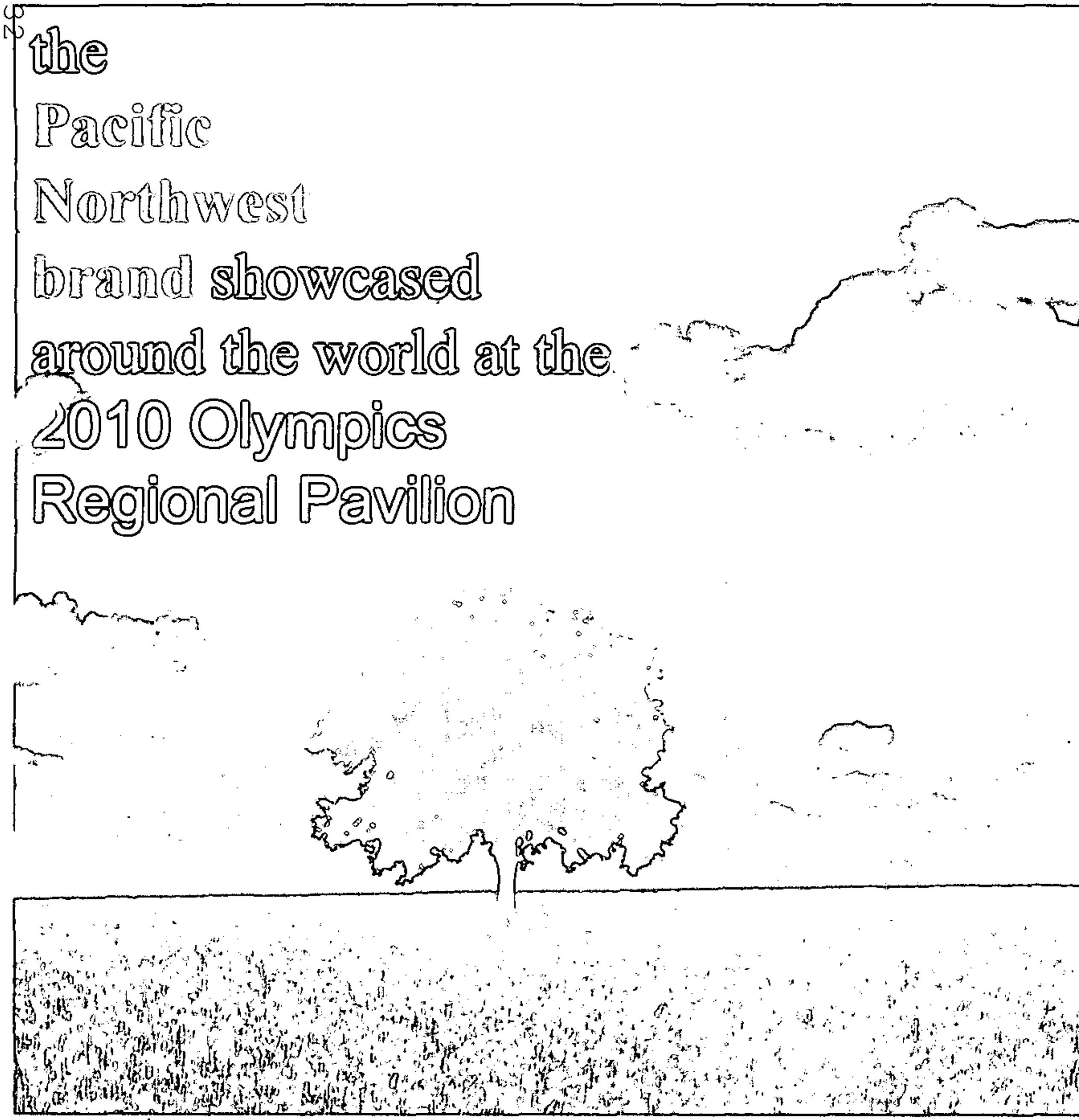
I430

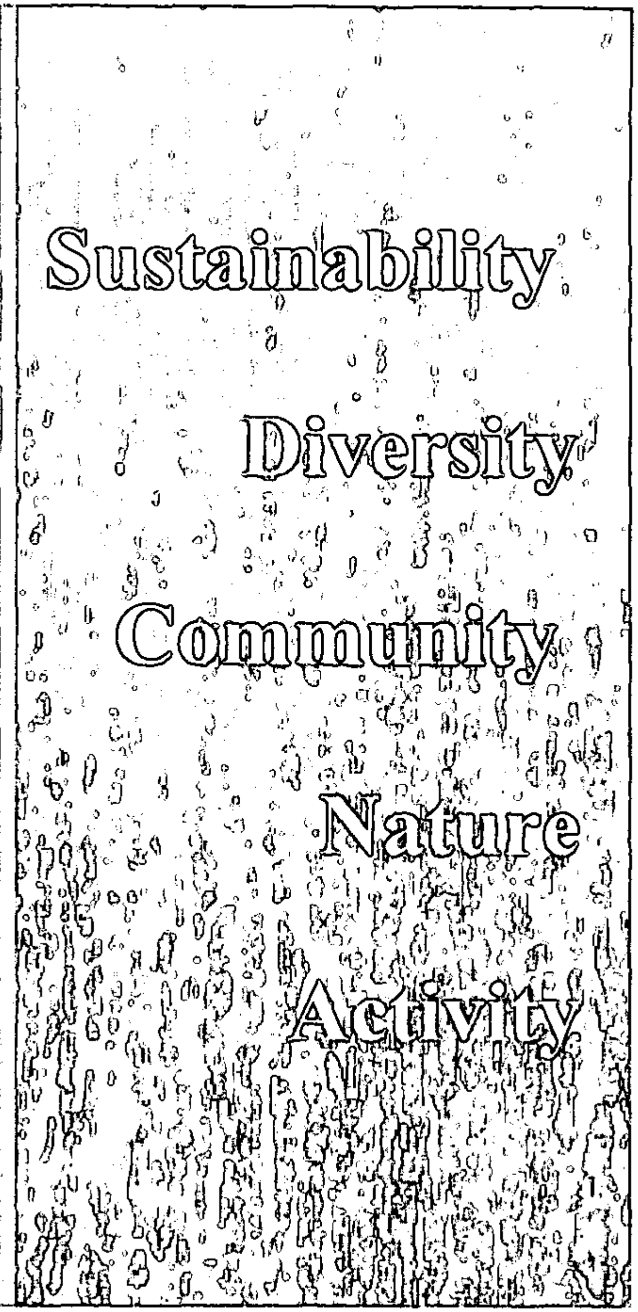

Arctic Ocean
East Siberian Sea
Chukchi Sea
Beaufort Sea
RUSSIA
UNITED STATES
CANADA
Bering Sea
Pacific Ocean
Arctic Ocean
NORTH POLE
ARCTIC CIRCLE
Asia
Russia
Norway
Europe
Canada
North America
Baffin Island
Greenland
Floating Wind
Turbine Concepts
Ketchikan Shipyard
•Strategic Products
•Competitive Standards
•Strategic Location

3-25-09 Overview: 2010 Winter Olympics Pavilion

<target><bill></bill><subject>3-25-09   Overview 2010 Winter Olympics Pavilion</subject><comm>SWTR26</comm></target>

1492





FIVETWOTEN

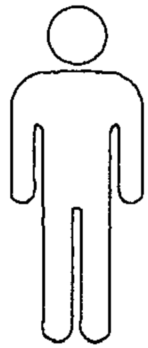
Pacific NorthWest Economic Region

Government of Saskatchewan

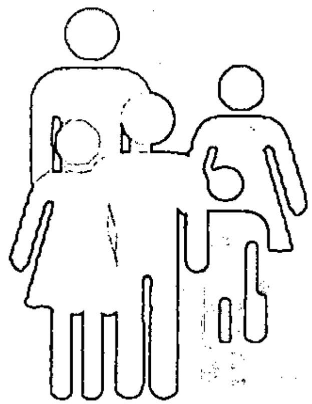
CASCADIA

OREGON

2010 Olympic and Paralympic Games

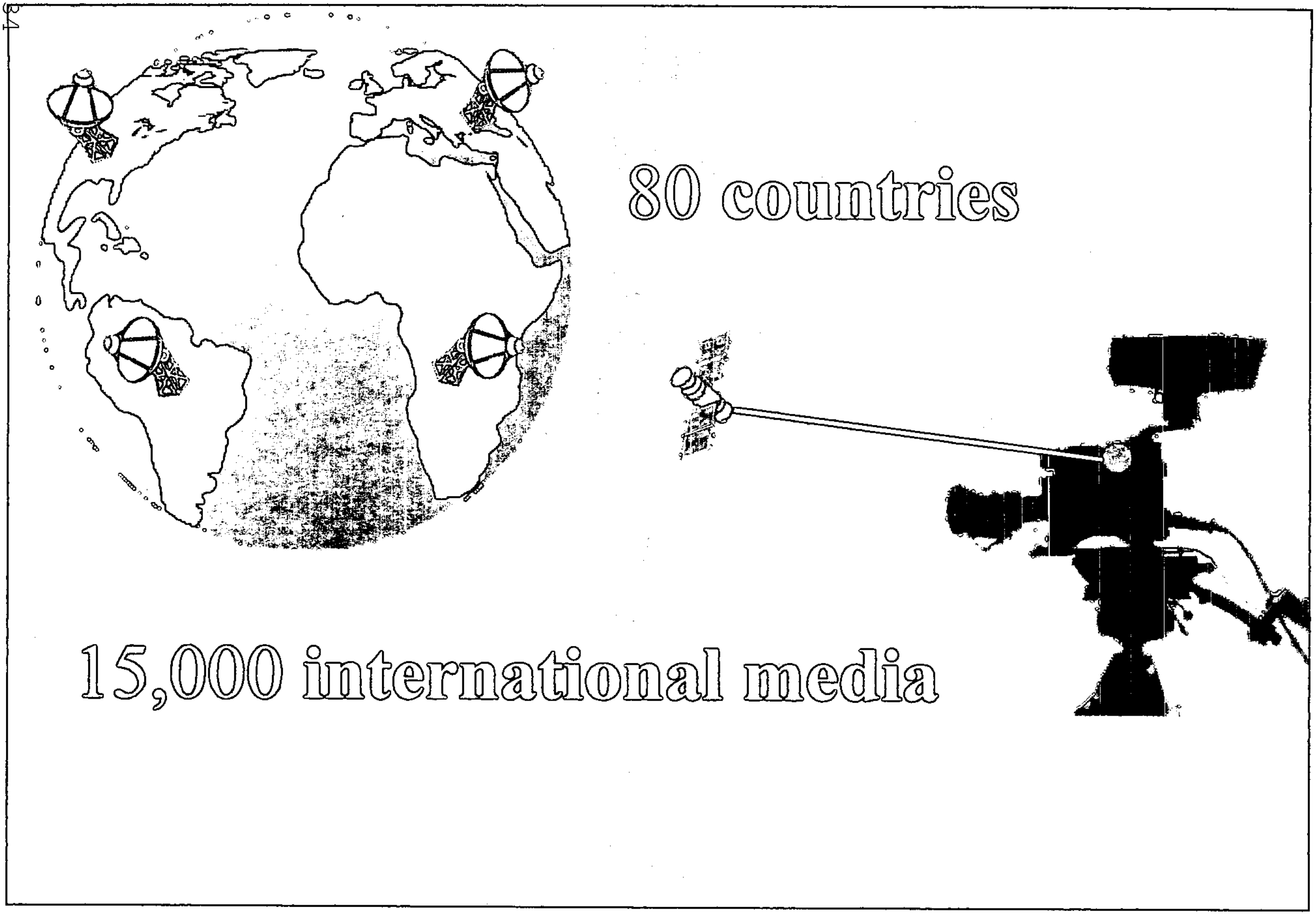


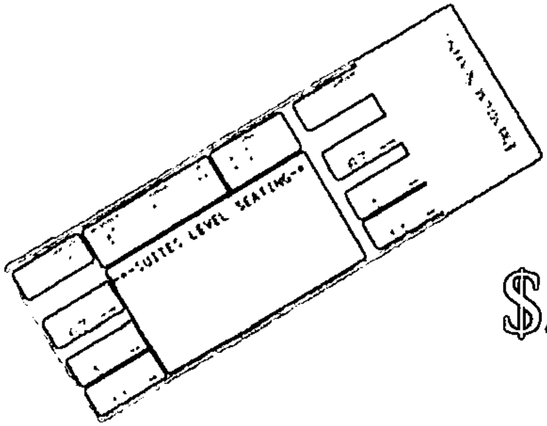
3,000,000,000 viewers



250,000 + visitors

5,500 athletes


80 countries
15,000 international media



$345,000,000 tickets ordered

M	T	W	T	F	S	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	$\boxed{27}$
28	29	28	30	31		

Days total

17 days of Olympic Games

10 days of Paralympic Games

1436

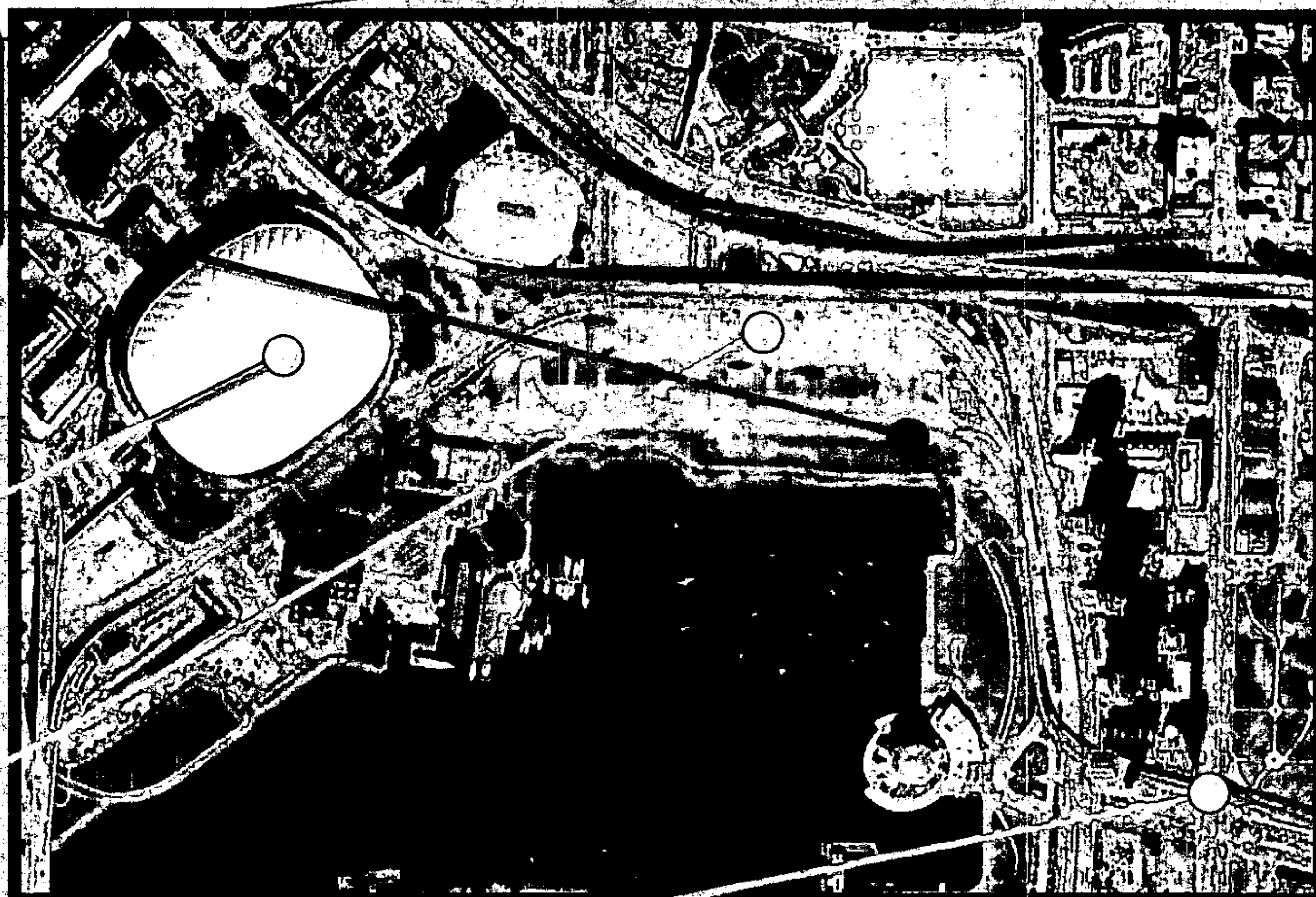
The *Best* Location at the Olympics Games

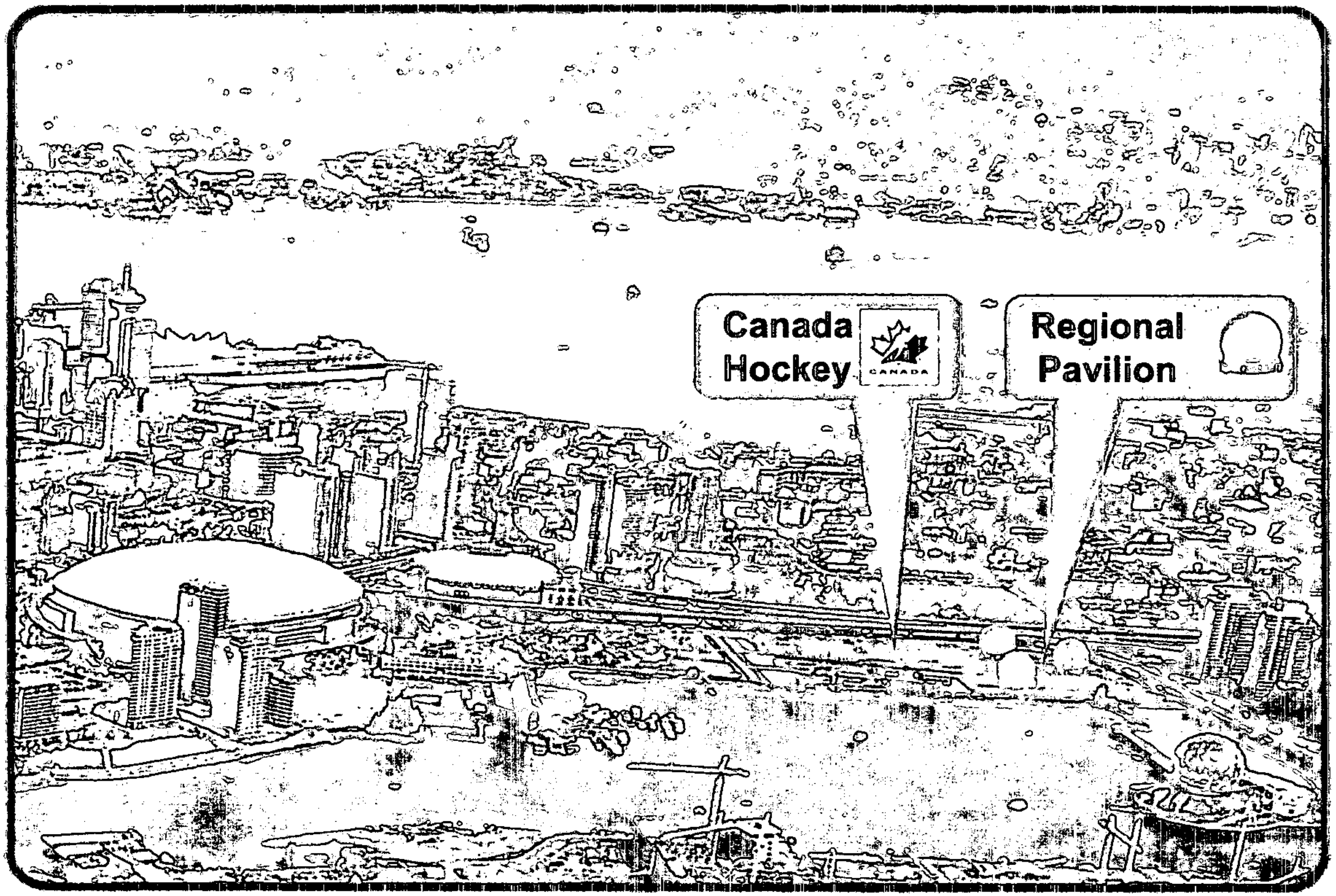
Regional Pavilion

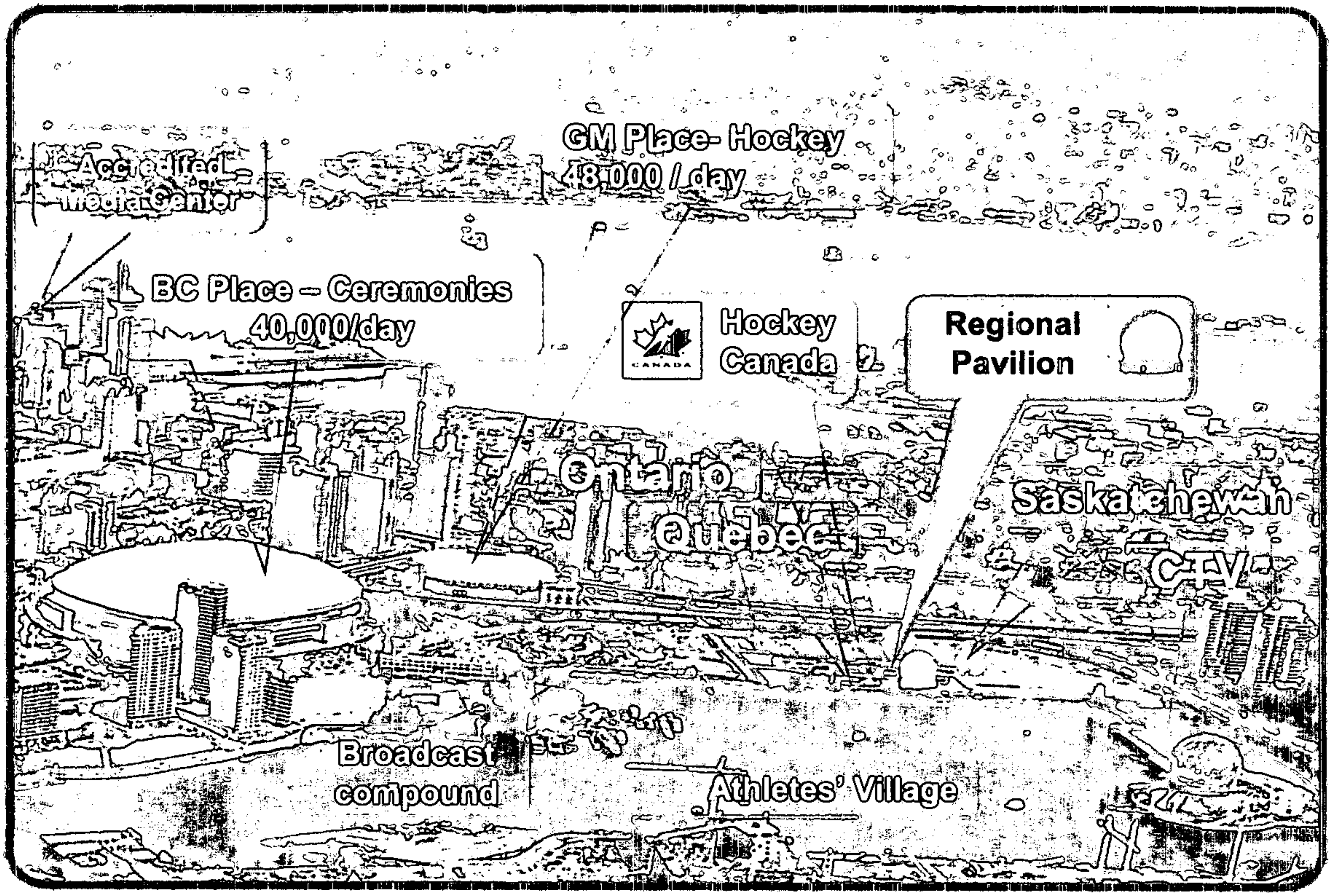
BC Place Stadium

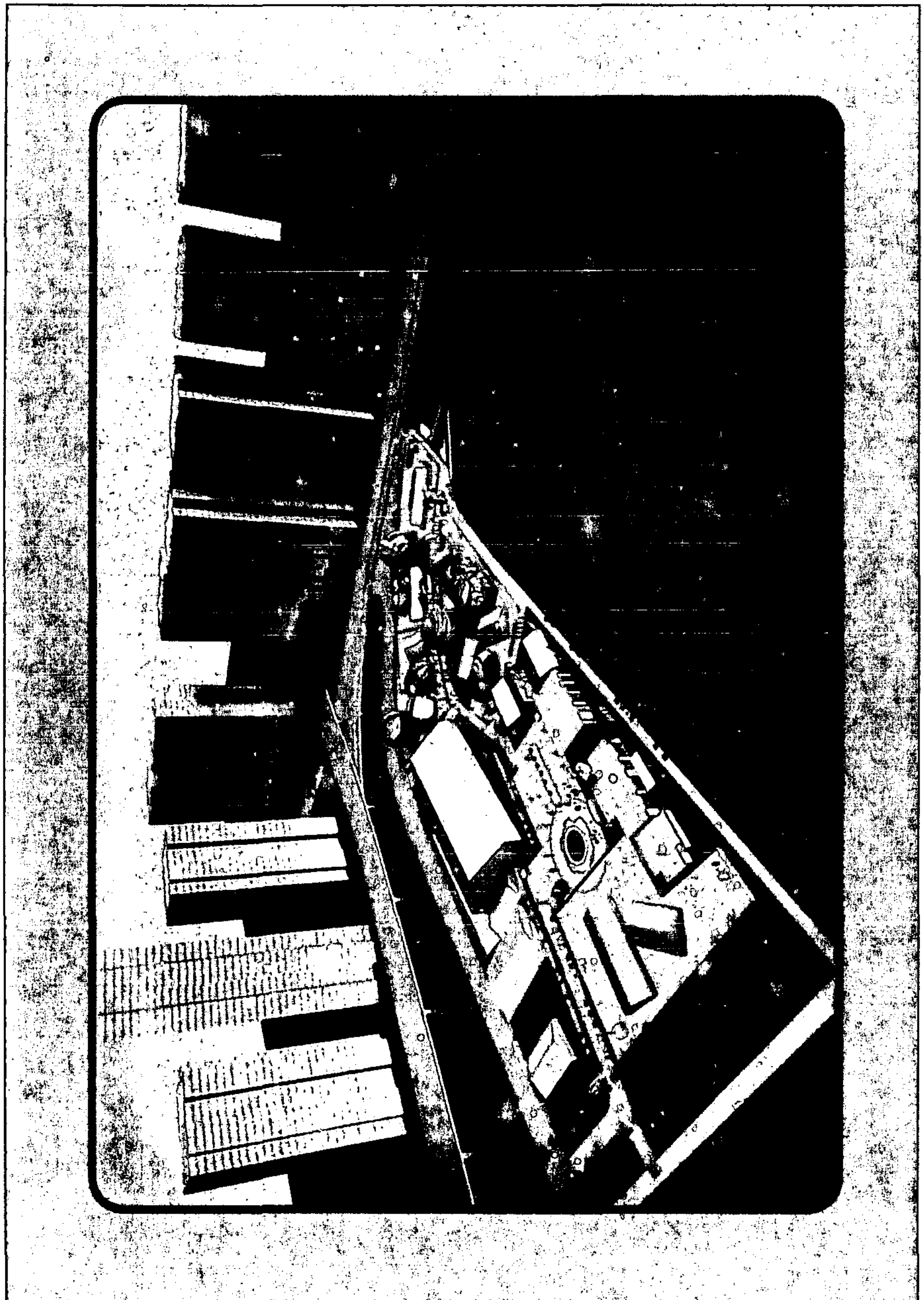
Hockey Canada

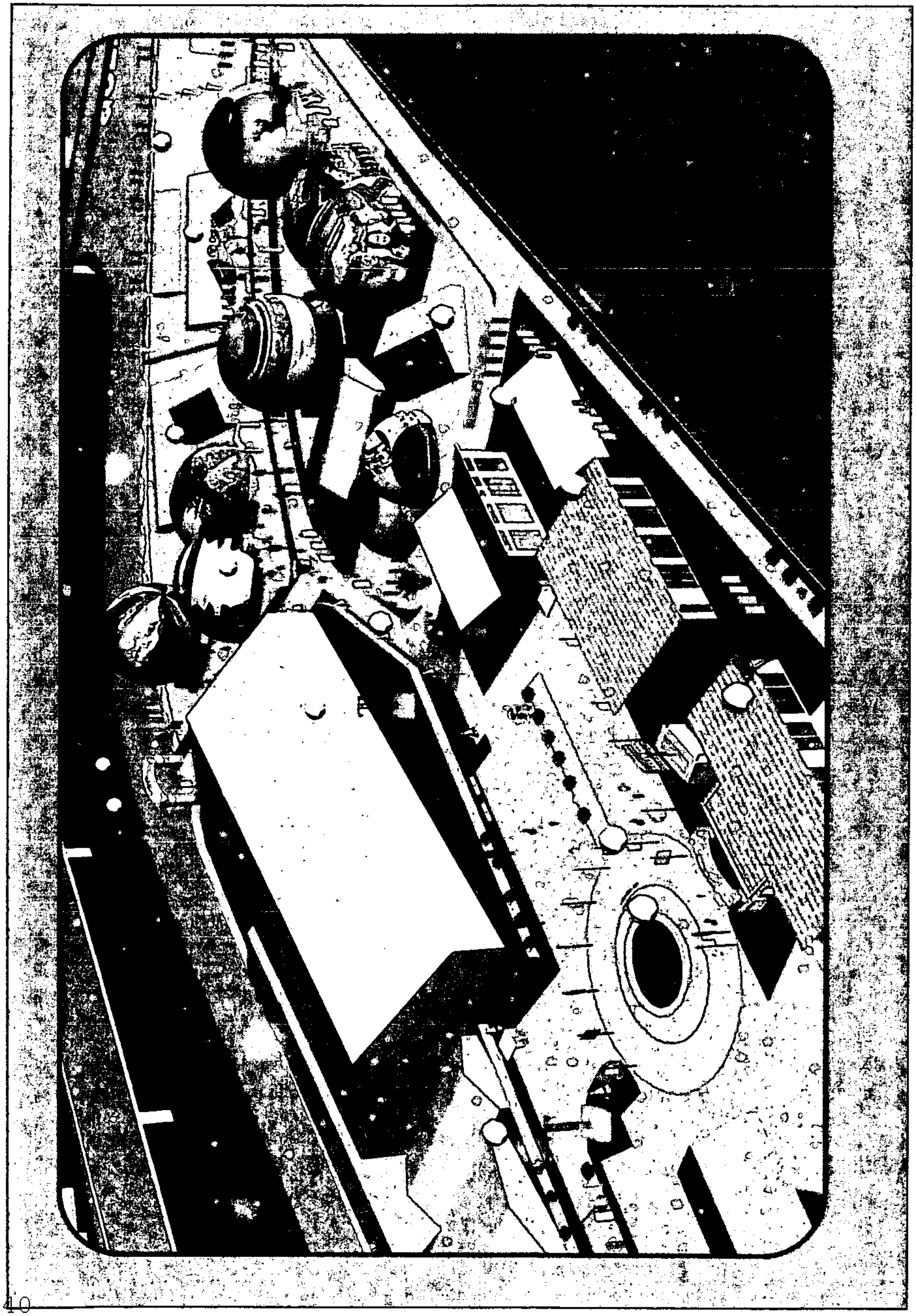
Main Skytrain Station

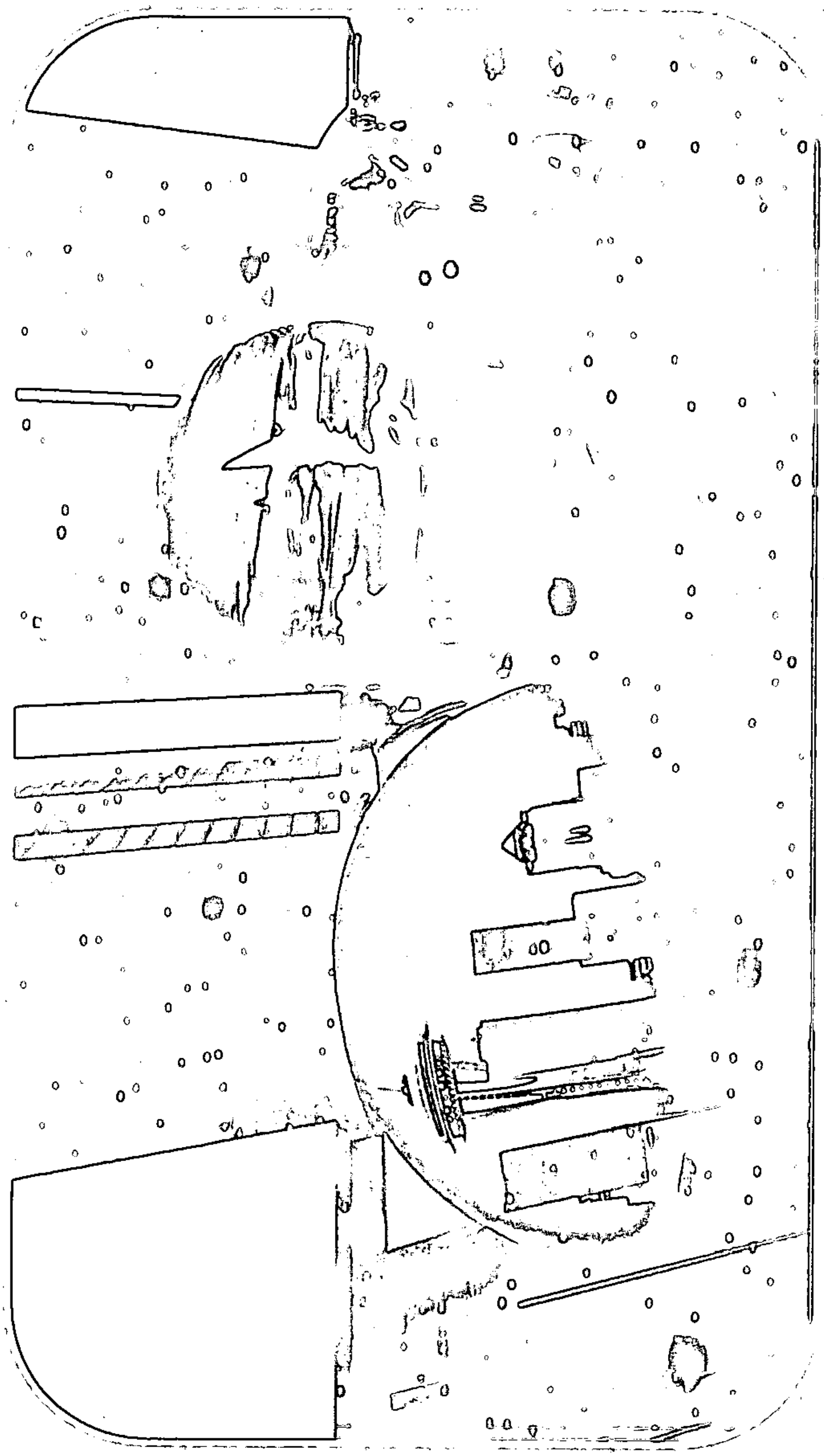


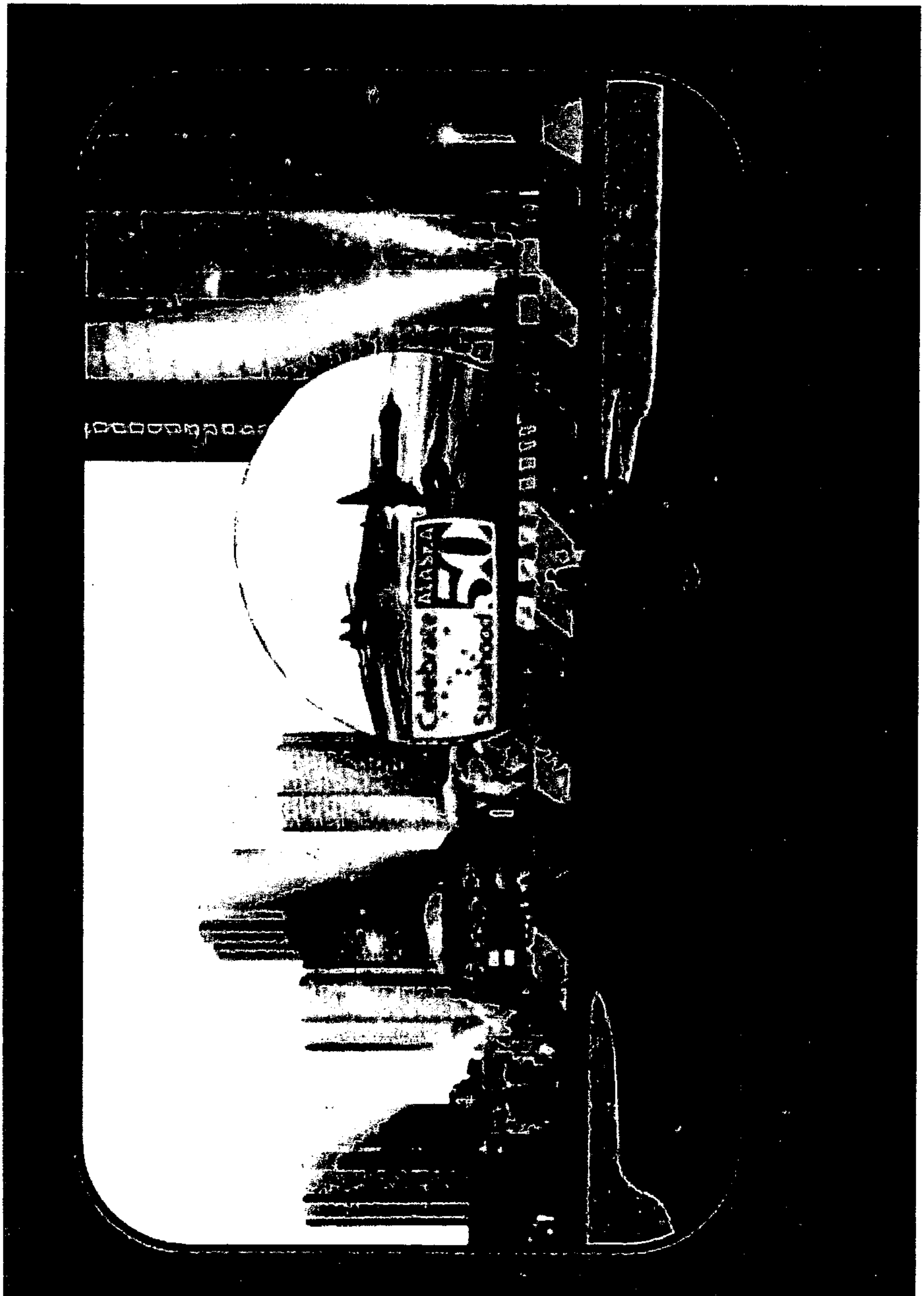

Canada Hockey
CANADA
Regional Pavilion

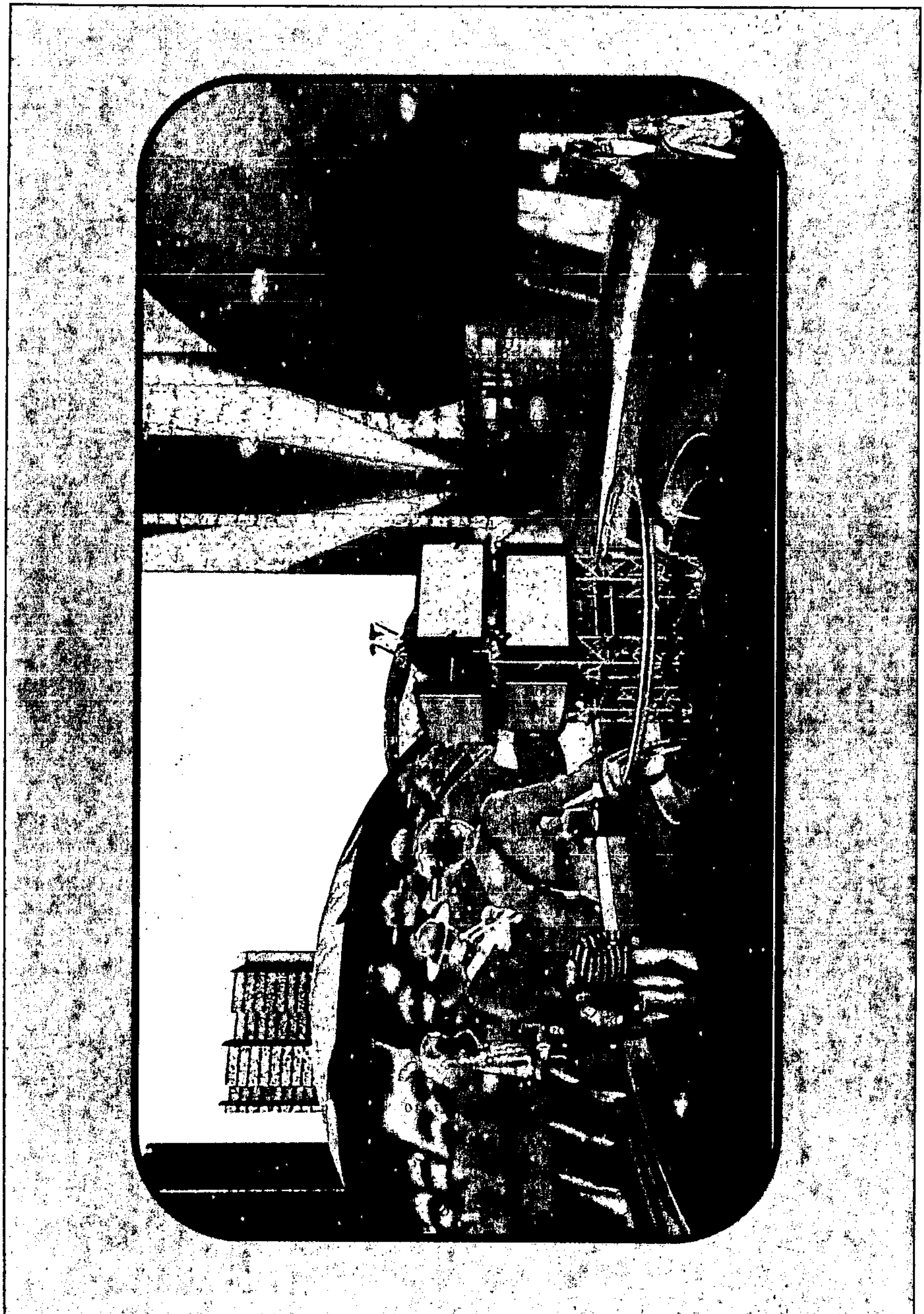

GM Place- Hockey
48,000 / day
Accredited
Media Center
BC Place – Ceremonies
40,000/day
Hockey
Canada
CANADA
Regional
Pavilion
Ontario
Quebec
Saskatchewan
CTV
Broadcast
compound
Athletes' Village





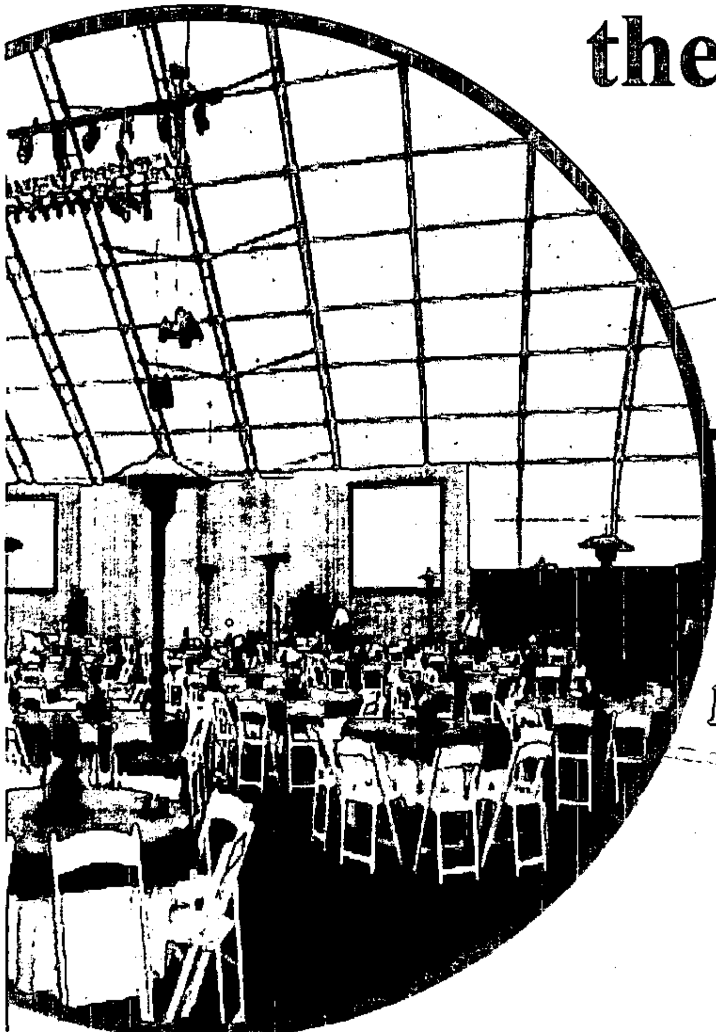



Celebrate
ALASKA
50
Statehood



1444

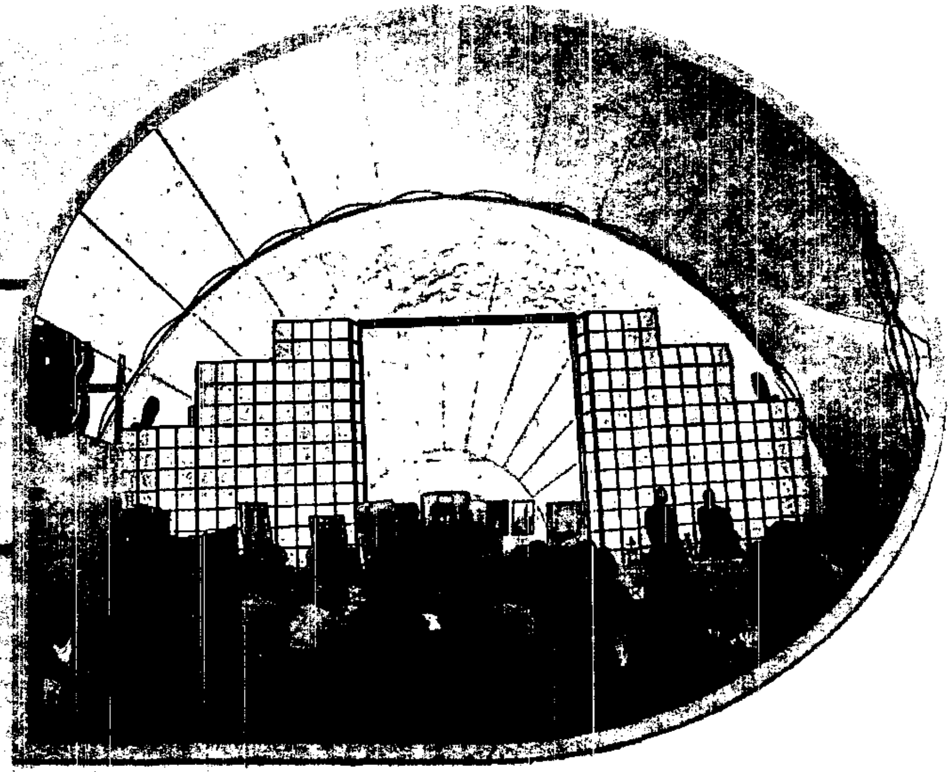
The best location *deserves* the best structures



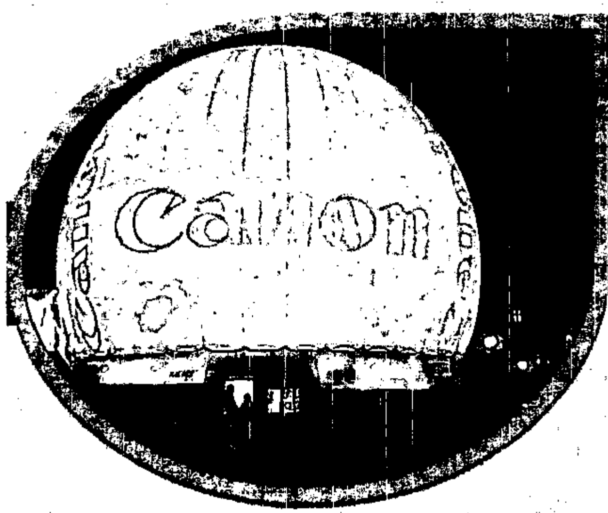
food and beverage space

retail opportunities

creative license for
shows and presentations

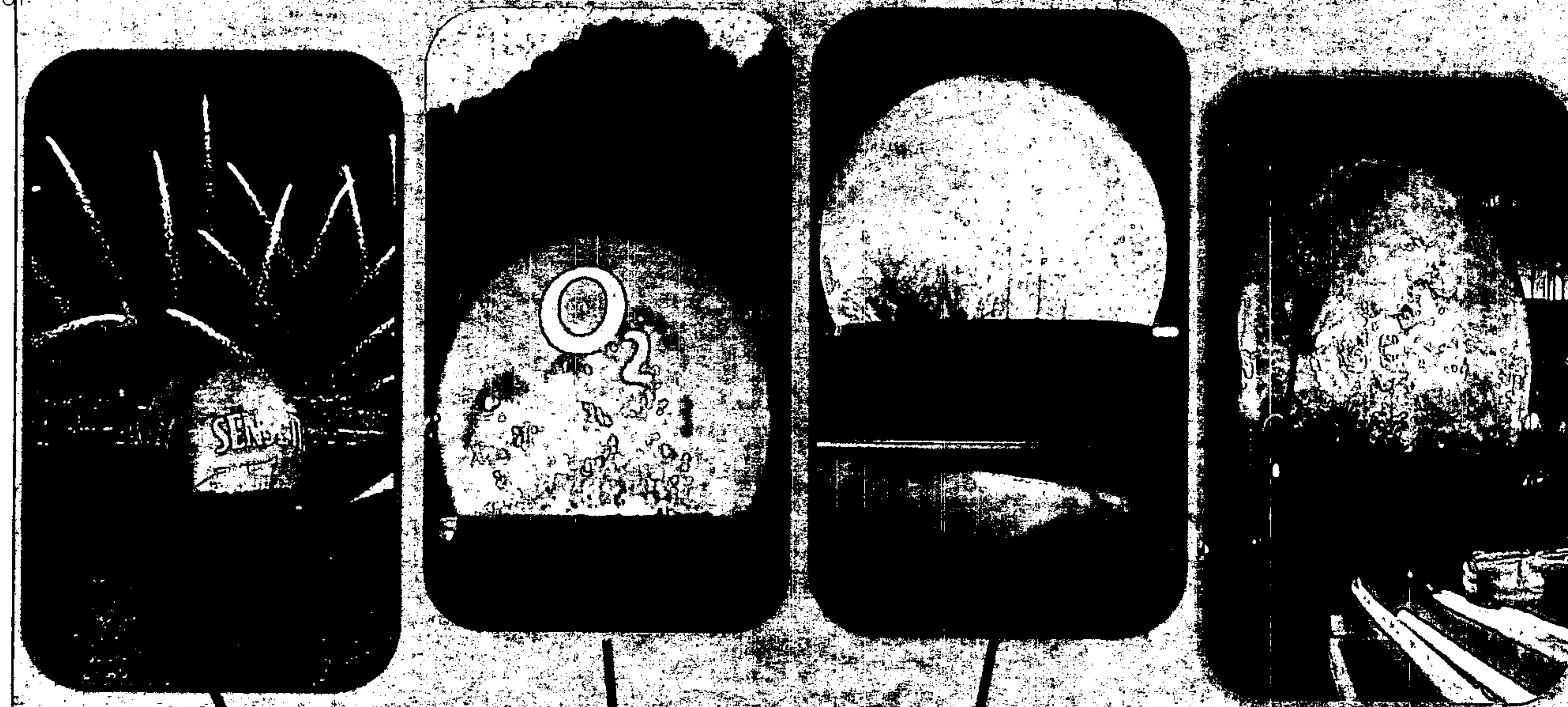


regional media center



multimedia staging
and exhibits

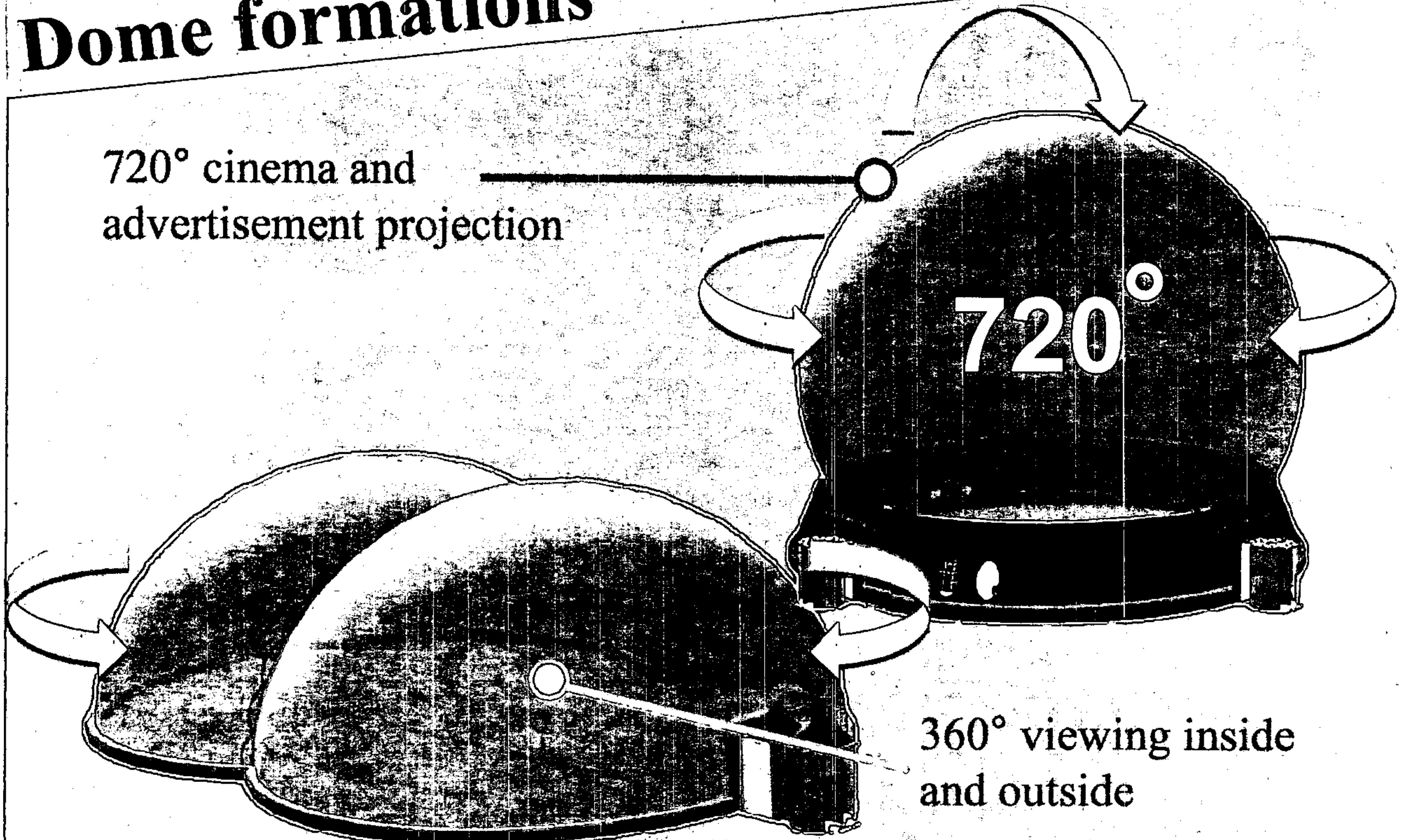
1446



Maximize *your* brand's visibility

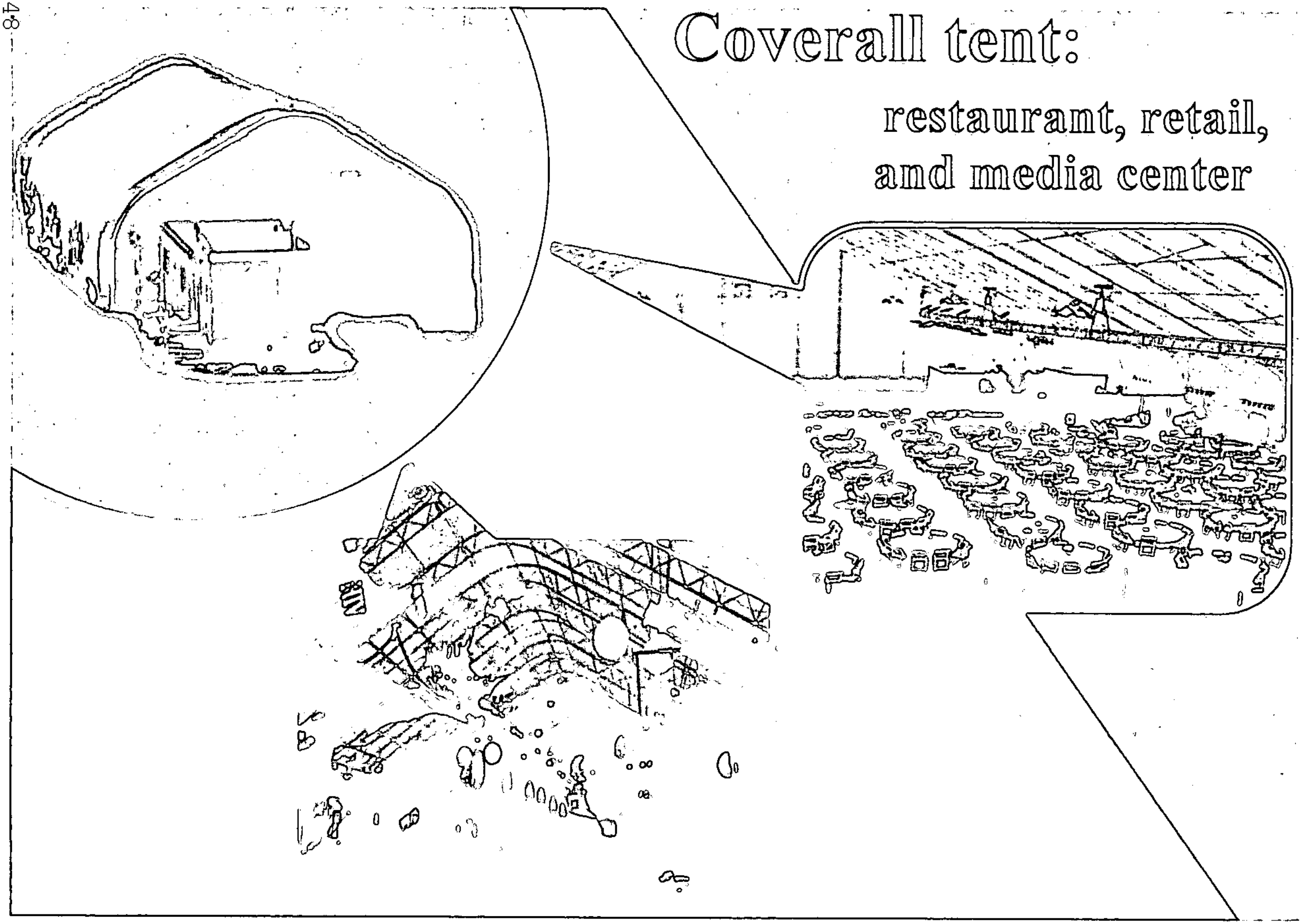
1447

Dome formations



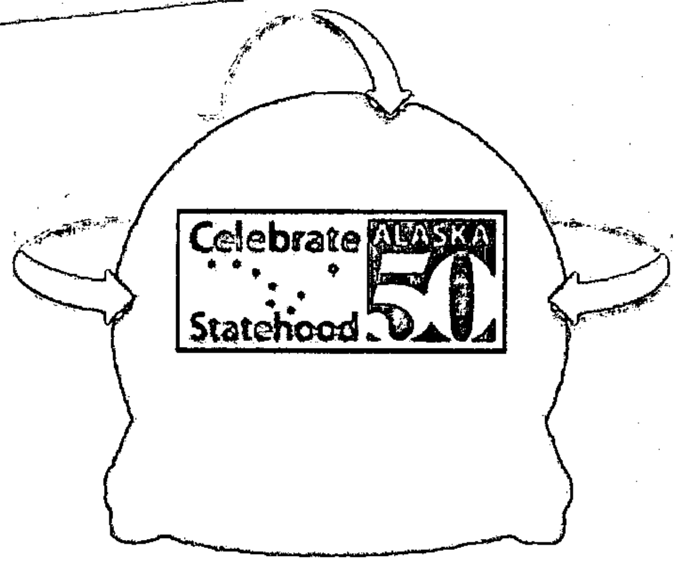
Coverall tent:

restaurant, retail, and media center



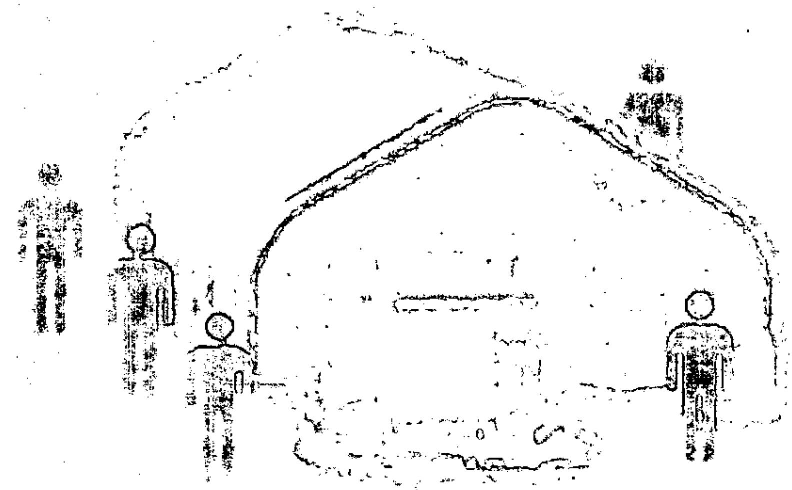
Partnership Opportunities

ACCESS to:



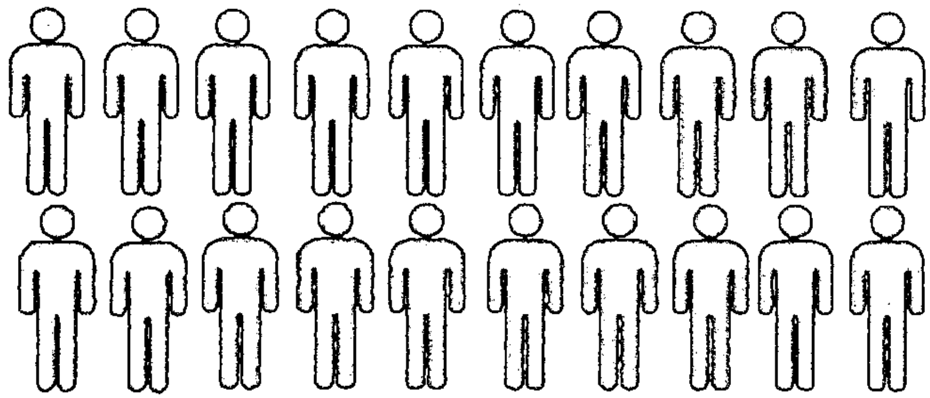
Indoor/ outdoor 720° projection technology

Event space for private parties and social events



MARKET to:

an estimated 500 people per hour



Celebrate ALASKA 50 Statehood

exclusive signage inside/ outside structure, fence perimeter, or stand-alone possibilities

	Public Sector Partnership
Portion of dome branding	○
Media/ Event integration opportunities	○
Olympic event hospitality	○
Cost	US $250,000

- ✓ Dome branding time
- ✓ Integration into regional tourism and sustainability stories
- ✓ Inclusion on static signage
- ✓ Alaska Day at the Pavilion
- ✓ Invitations to all business events

1452

To learn more, contact:

Ian Burkheimer

Pacific NorthWest Economic Region/ Five Two Ten

206.443.7723

ianb@pnwer.org

www.2010pavilion.com

1453

The Regional Pavilion at the 2010 Winter Olympics

The World's Gateway to the Pacific Northwest at the 2010 Vancouver Olympic Games

Proposal Prepared for

The State of Alaska

FIVETWOTEN Government of Saskatchewan CASCADIA OREGON

1454

The Olympics has the power to change the world. It has the power to unite people in a way that little else does.

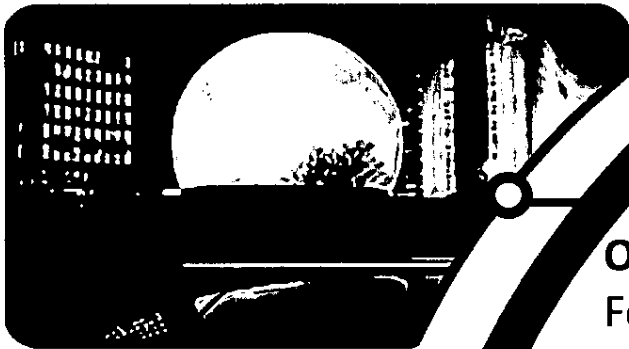
-Nelson Mandela

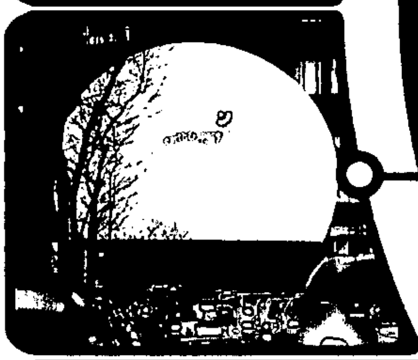
The Olympics remain the most compelling search for excellence that exists in sport, and maybe in life itself.

-Dawn Fraser, Australian Swimmer and 3 time Olympic Medalist

NOTE: Five Two Ten is the entity executing the 2010 Regional Pavilion project on behalf of partners including the Pacific NorthWest Economic Region. Five Two Ten and the Pacific NorthWest Economic Region currently are not agents nor official partners of the Vancouver Organizing Committee of the 2010 Olympics and Paralympics, and does not offer access to official marks and logos.

1455





Key Facts:

Pavilion:

Operations:
February 1st-March 31st, 2010
(Some preliminary operations in January 2010)

Location:
Immediately adjacent to Opening/Closing and Hockey Venues. Easily accessed by SkyTrain and Amtrak passengers

Daily traffic:
From 4,000 to 7,000

Footprint:
5,000 to 10,000 sq. ft.

Olympics:

Viewers:
3,000,000,000+

Pre-sale ticket orders:
$345,000,000

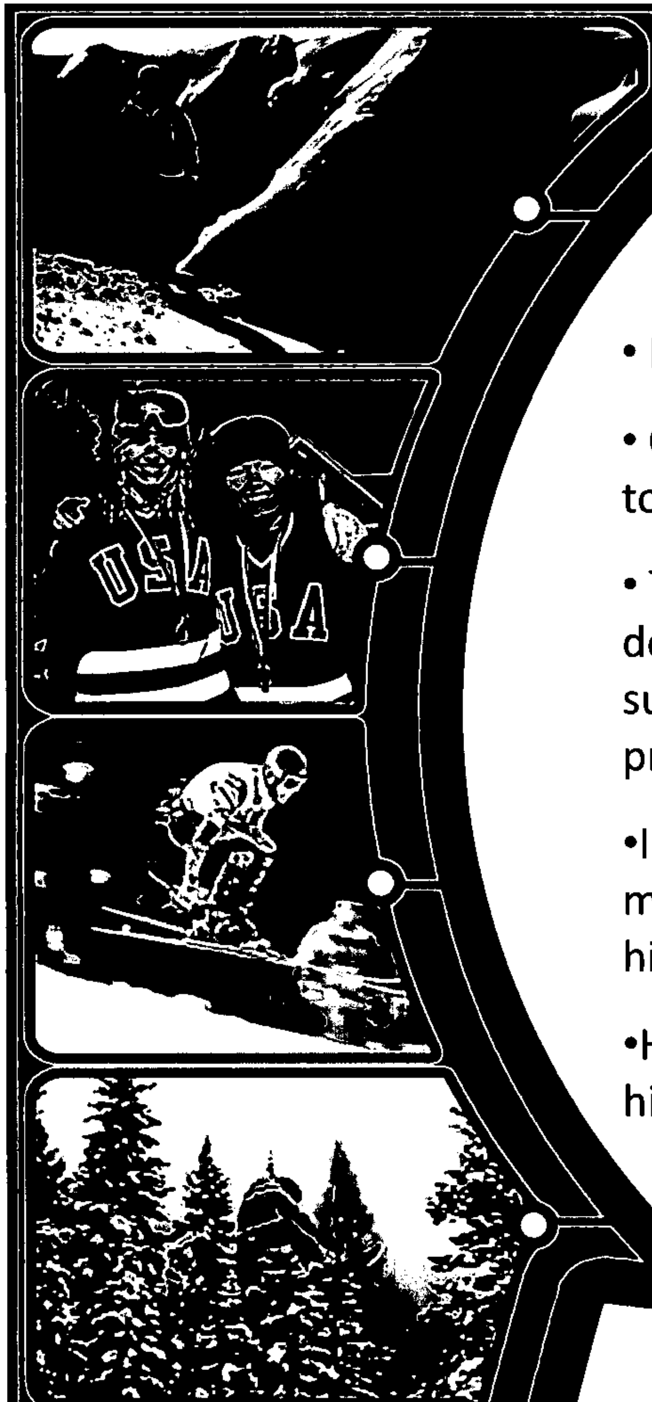
Number of Tickets:
1,100,000+

Top US Markets:
Washington and California

Athletes:
Over 5,000 from 80 different countries

Number of Visitors:
250,000+

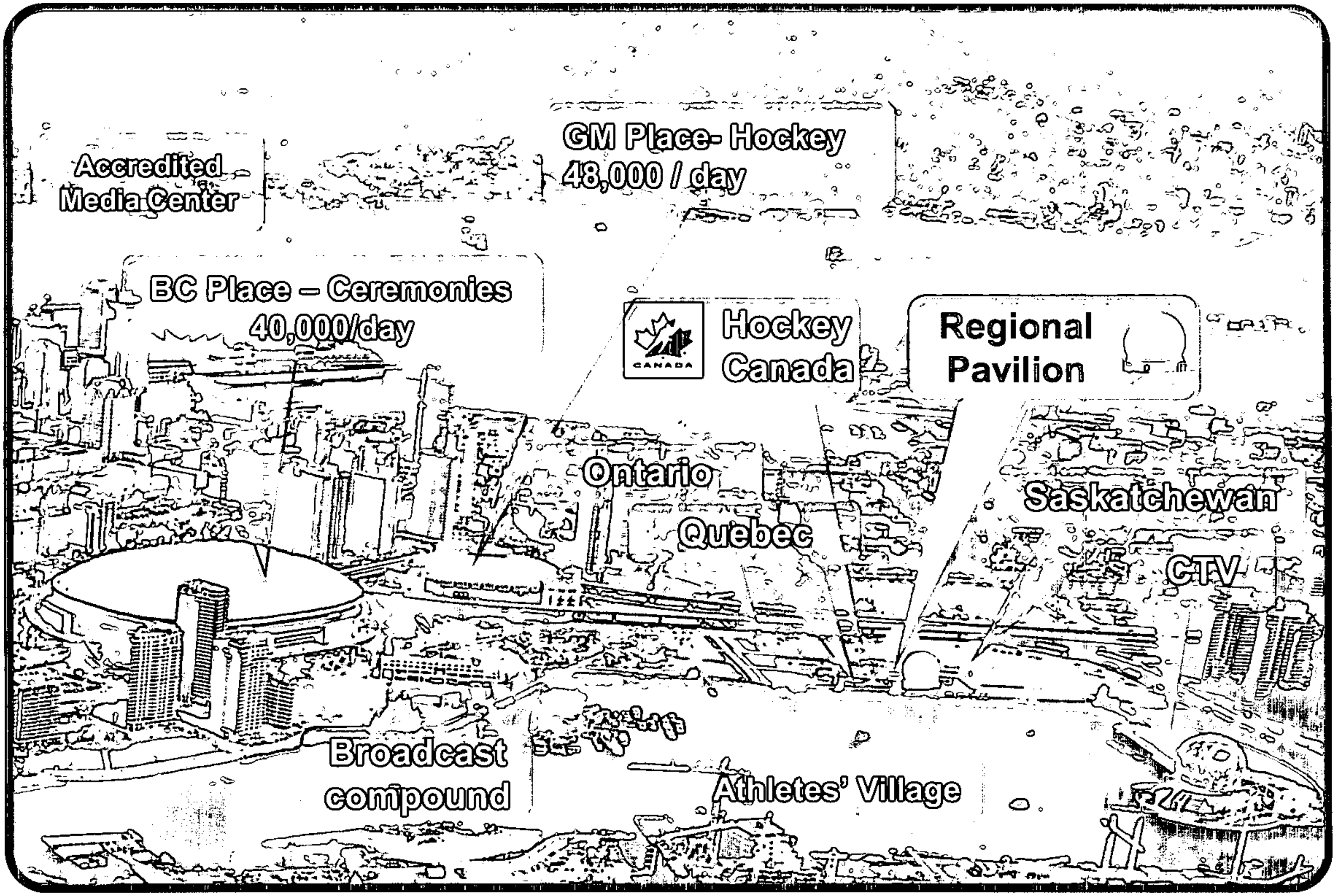
1456



Taking your message to the world

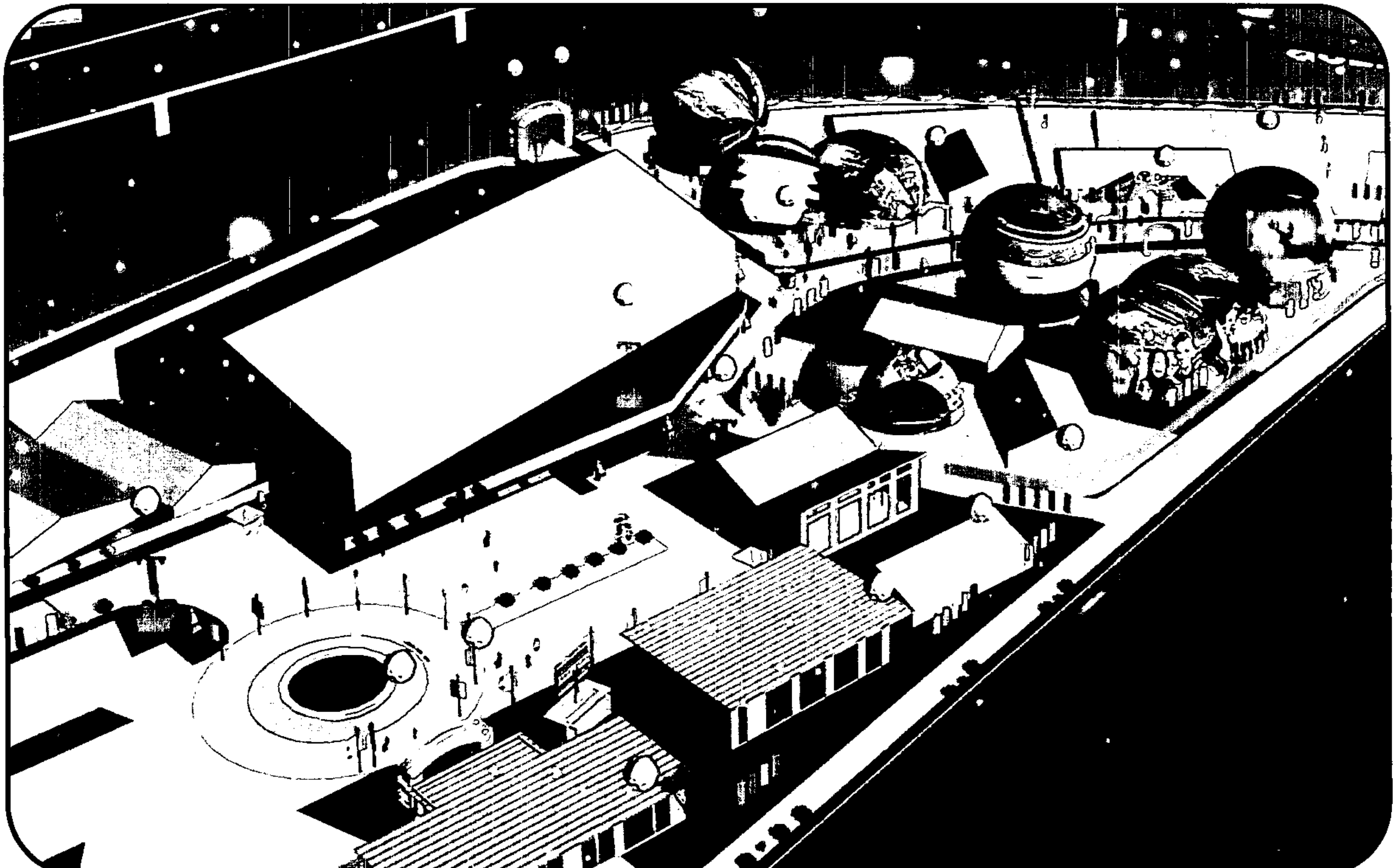
- Projected 100,000-150,000 walk-through visitors.
- On the main access route for nearly two million people to the two primary venues for the Winter Olympics.
- The Regional Pavilion is the tourism and marketing destination for innovative organizations with a focus on sustainable technologies, innovation and best renewable practices.
- Includes a space to attract some of the 18,000 media members attending the Games to learn the stories and history of the State of Alaska.
- Highly visible, projection based structures in a dynamic, highly accessible location.

The Best Location in Vancouver

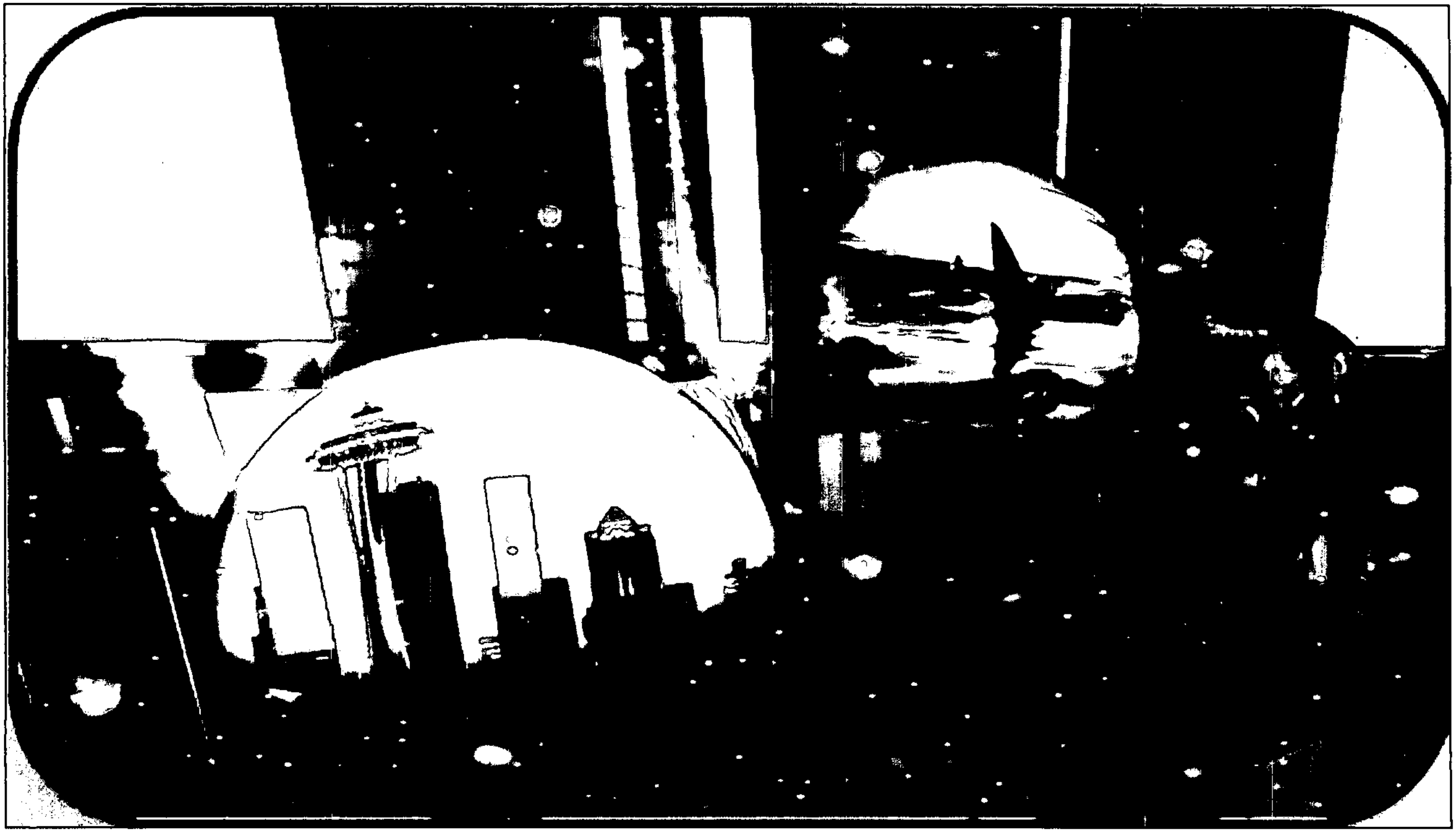


1457

Highly Visible



Flexible and interactive



1459

1460

Pavilion Attributes (1)

- ## Hospitality and Entertainment space

This highly visible structure will display artwork and video from participating partners, with a very limited amount of external logo display. Partners will be able to host hospitality events inside the sphere; and educational, cultural and entertainment events will be presented on an integrated stage .

- ## Public Exhibition Pavilion

The Public Education Pavilion will be housed in adjoining three-story high dome structure. With a combination of exhibits and activities taking place within, messages relevant to partners such as green living and sustainability can be broadcast both on the interior and to a large extent on the exterior surface of the dome, reaching attending spectators and a global television audience.

- ## Retail Space

Retail capacity is critical to monetizing the opportunity presented with 4,000 to 7,000 spectators expected to visit the Regional Pavilion each day of the Olympics and in smaller numbers during the Paralympic Games. The retail space will be on the main pathway of visitors, providing maximum exposure to the products from the State of Alaska.

1461

Pavilion Attributes (2)

- ## Global Media Center

Currently the regional Pavilion plans to host a media center to distribute stories and information about partners, host news conferences and information briefings, and be a second home to the unaccredited media at the Olympics.

- ## Food and Beverage Area

Together with our partner, the Province of Saskatchewan, we will host a food and beverage area at the pavilion, with a goal of showcasing the agricultural, marine and culinary products ofAlaska.

1462

Target Audience

- ## International Tourists

Visitors will have the opportunity to experience the larger region by visiting the Regional Pavilion. Future business investment and tourism will be the by-products for this audience.

- ## Pacific Northwest and Vancouver Citizens

The largest population of visitors to the Olympics will come from the regions 22 million inhabitants. These visitors will be looking for new business and recreation opportunities as well as ways to "continue" their Games experience. We will work to reach them through travel and sustainability messages.

- ## Publics interested in sustainability practices

The Olympic Games will draw people from every corner of the globe, but one commonality between these demographics will be their interest in business practices that are bettering society and providing solutions for a "greener" future. The State of Alaska can showcase its continuing efforts in the Pacific Northwest's sustainability and renewable resource leadership.

- ## Sports Enthusiasts

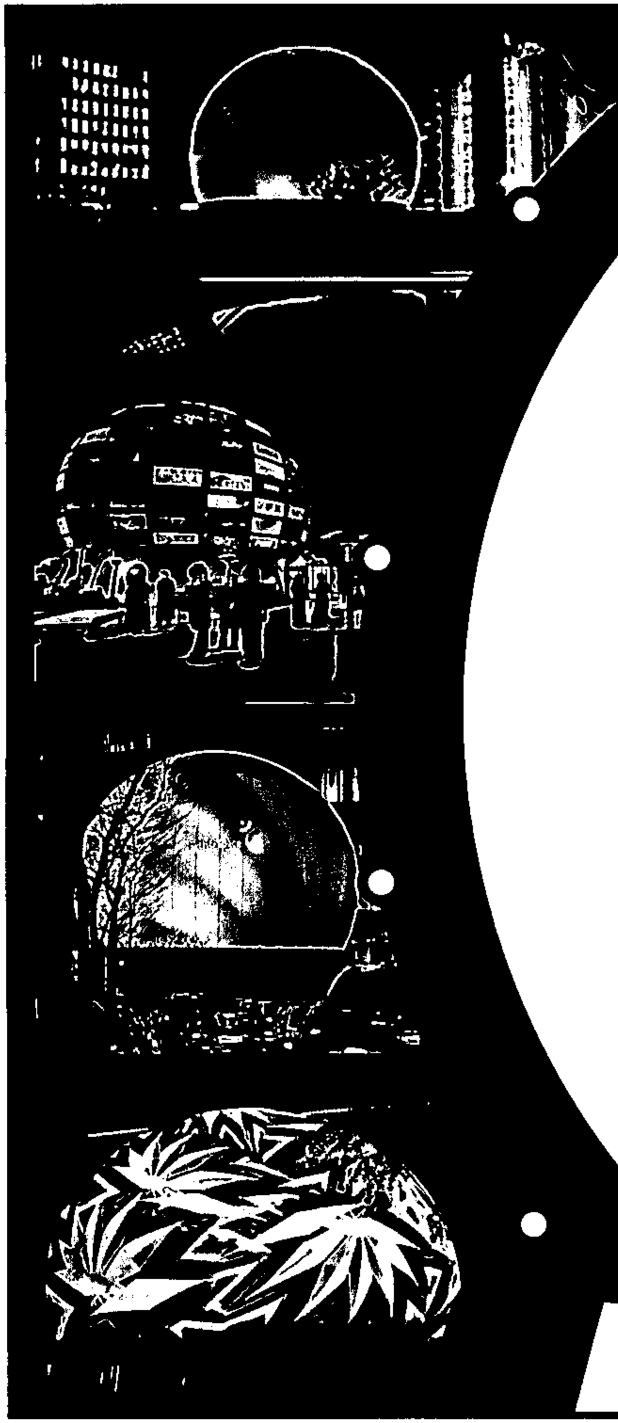
A majority of the individuals and organizations who will visit the Olympic venues of Vancouver will show support for the athletes and sports. Possibility to showcase various sport opportunities throughout the State of Alaska.

1463

Media Coverage

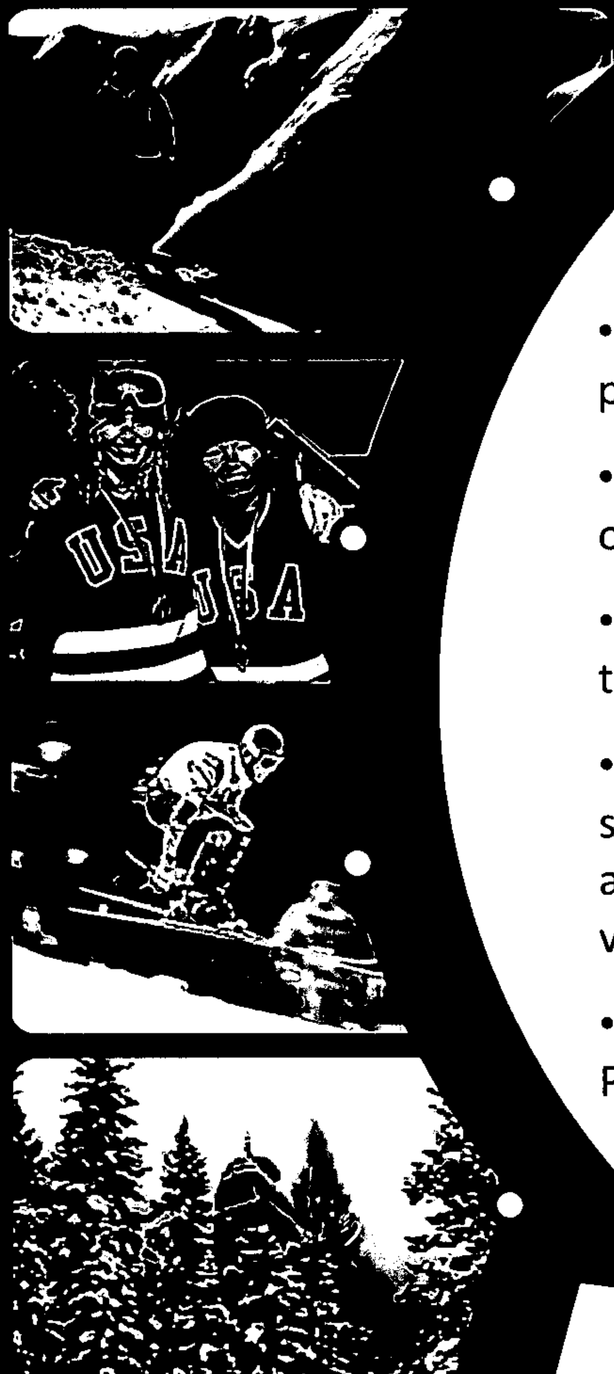
- Estimated 18,000 total media at 2010 Olympics
  - ❖ 4,000-5,000 accredited media
  - ❖ 11,000-14,000 unaccredited media
- The Regional Pavilion will host a regional media center to present:
  - ❖ Timely story ideas, content, news conferences and special activities
- The media center will provide:
  - ❖ Key media workspace, press conference venues, private interview space, live broadcast staging, and other services for the media to cover non-sports topics

1464



Features and Benefits:

- Regional Pavilion public partners receive the following comprehensive package of benefits:
  - ✓ The most visible location in Vancouver during the 2010 Olympics for Alaska's brand
  - ✓ Unsurpassed walk-by and walk-through traffic
  - ✓ Your home for hospitality receptions with other regional premiers and governors
  - ✓ Share your culture, history and arts with visitors though multi-media and live performances
  - ✓ Promote your jurisdictions leadership in sustainability and innovation practices
  - ✓ Marketing opportunity that will never be available again
  - ✓ A Featured day for Alaska to provide additional content, host a hospitality event and become the lead "tenant" for a day during the Olympics



Benefits: Business, Culture and Sports

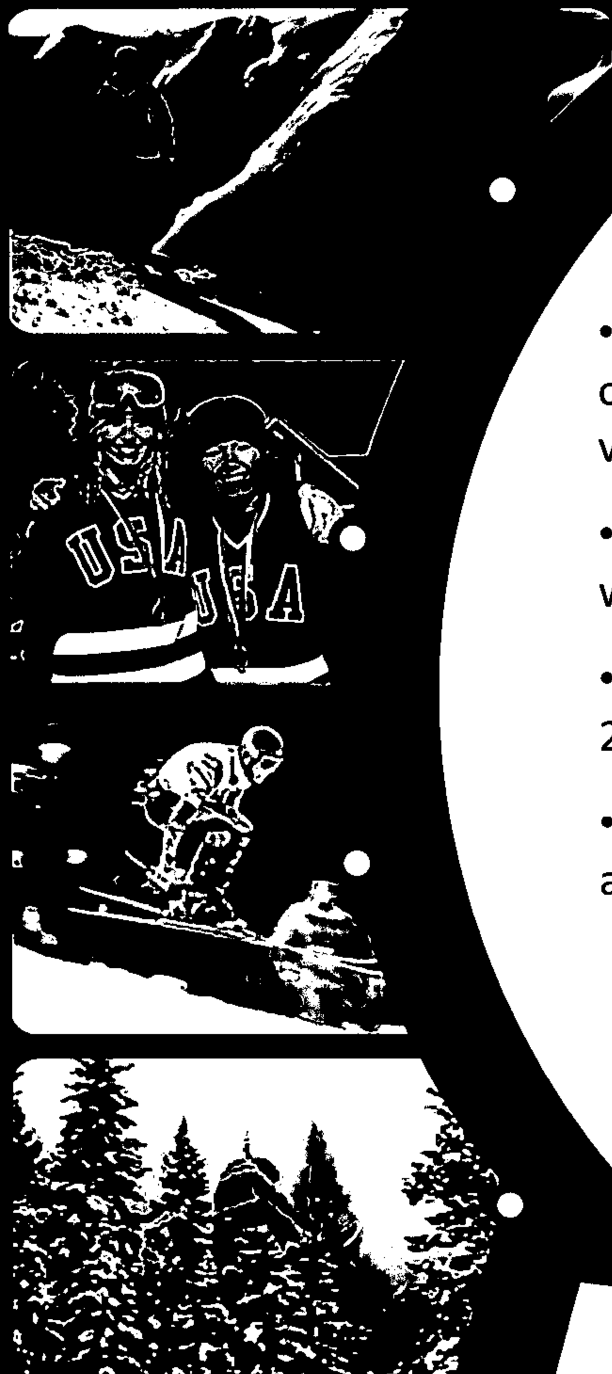
- Invitation for Alaska groups and sponsored entities to perform/exhibit in Vancouver during the 2010 Olympics
- Rights to have Alaska volunteers on site during the operations of the pavilion
- Ability to invite other sub-state level public entities to take part as cultural/tourism partners and share costs
- Participation in a regional travel operators and media special reception at the Regional Pavilion, including the ability to make a presentation and invite guests of high value to Alaska.
- Networking possibilities, including other Regional Pavilion and PNWER partners

1466

Benefits: Economic Development

- Representatives from Alaska become part of the design team
- Alaska will be made a primary story telling pathway of sustainable tourism, economic, social and environmental development
- Participation in allocated retail space (negotiated) to exhibit and sell Alaska products
- Participation includes broadcast messaging in media dome and strong presence in public pavilion and exhibition venue; encourages high visibility for tourism and business networking*

*Exact square footage will be based on the total number of investors in the pavilion, however it will exceed 150sq. ft. minimum.



Benefits: Marketing and Promotions

- Ability to do promotional activities , provide promotional content to, and data gather from the 100,000-140,000 visitors coming through the pavilion
- Limited external signage for the 1,000,000 to 1,800,000 walk by traffic
- Ability to do co-promotion with Alaska entities and the 2010 Regional Pavilion
- Ability to sell merchandise and promotions for the Alaska at the Pavilion.

1468

The State of Alaska

- ## Your $250,000 Investment:

✓ Display of digital media via broadcast dome

✓ Display participation in public pavilion

✓ Inclusion of cultural arts / artists to provide entertainment and education content in public pavilion

✓ Participation in allocated retail space (negotiated)

✓ Participation in the regional media center

✓ Alaska Theme day at the public pavilion

✓ A Hospitality event at the Pavilion for Alaska

- Participating Jurisdictions must provide the following beyond funding at their own cost:

  High Quality video, preferably in HD; a support person to work with the secretariat to integrate content; provision at own cost of arts and artists from jurisdiction; press releases, pre-written stories and other items for media center use; volunteers for the pavilion during operational timeframe; content related to sustainability and tourism themes for inclusion in the pavilion story; Governor/political leaders participation in hospitality events, provision at own cost for booth to be placed within pavilions public outreach area. While we cannot provide hotel rooms as part of the sponsorship, we can work with partners to make lodging arrangements at cost.

Other Notes:

- The raw land lease for the space is $55/square foot.
- This public sector investment opportunity is being made available to all PNWER jurisdictions, plus Manitoba.
- There are still private sector sponsorships available with one day specialized packages in the $50K range, and full time partnerships from $500K and up.
- With Alaska's good faith commitment to consider this investment, a state representative will be invited to the steering committee conference calls immediately.
- PNWER has been invited to become an official Olympics Partner, and should we become one, additional benefits will be made available to Alaska. (Decision April 2009)

Project References

- Oregon:

Amy Keiter, Office of the Governor, Amy.Keiter@state.or.us, 503-229-5113

- Saskatchewan:

Bruce Evans, 2010 Games Secretariat, bruce.evans@gov.sk.ca, 306-798-8762

Others available upon request

1471

Further information:

Contact:

Ian Burkheimer

2010 Olympics Program Manager

Pacific NorthWest Economic Region/Five Two Ten

206-443-7723

ianb@pnwer.org

www.2010pavilion.com

Note: All items included in this proposal are subject to change until final agreement between Alaska, the Province of Saskatchewan and the Five Two Ten Organizing Committee.

FIVETWOTEN Pacific NorthWest Economic Region Government of Saskatchewan CASCADIA OREGON

4-09-09 Overview: Advances in Neuro-surgery

<target><bill></bill><subject>4-09-09 Overview Advances in Neurosurgery</subject><comm>SWTR26</comm></target>

1473

Christie Artuso

Director, Neurosciences

Providence Alaska Medical Center

Delivering Quality Healthcare Through Technology

Technology continues to advance and facilitate improved quality in the delivery of healthcare in a dynamic and complex environment.

How does technology impact our healthcare system?

- Clinical information systems [electronic medical records]
- Computer-chip–based clinical monitoring devices
- Advanced Web-based applications with remote, wireless communication devices [REACH Call]
- Clinical decision support software [ImPACT] [eICU]

Clinical Transformation.......

- **The concept of clinical transformation is developed with new models of care delivery being**

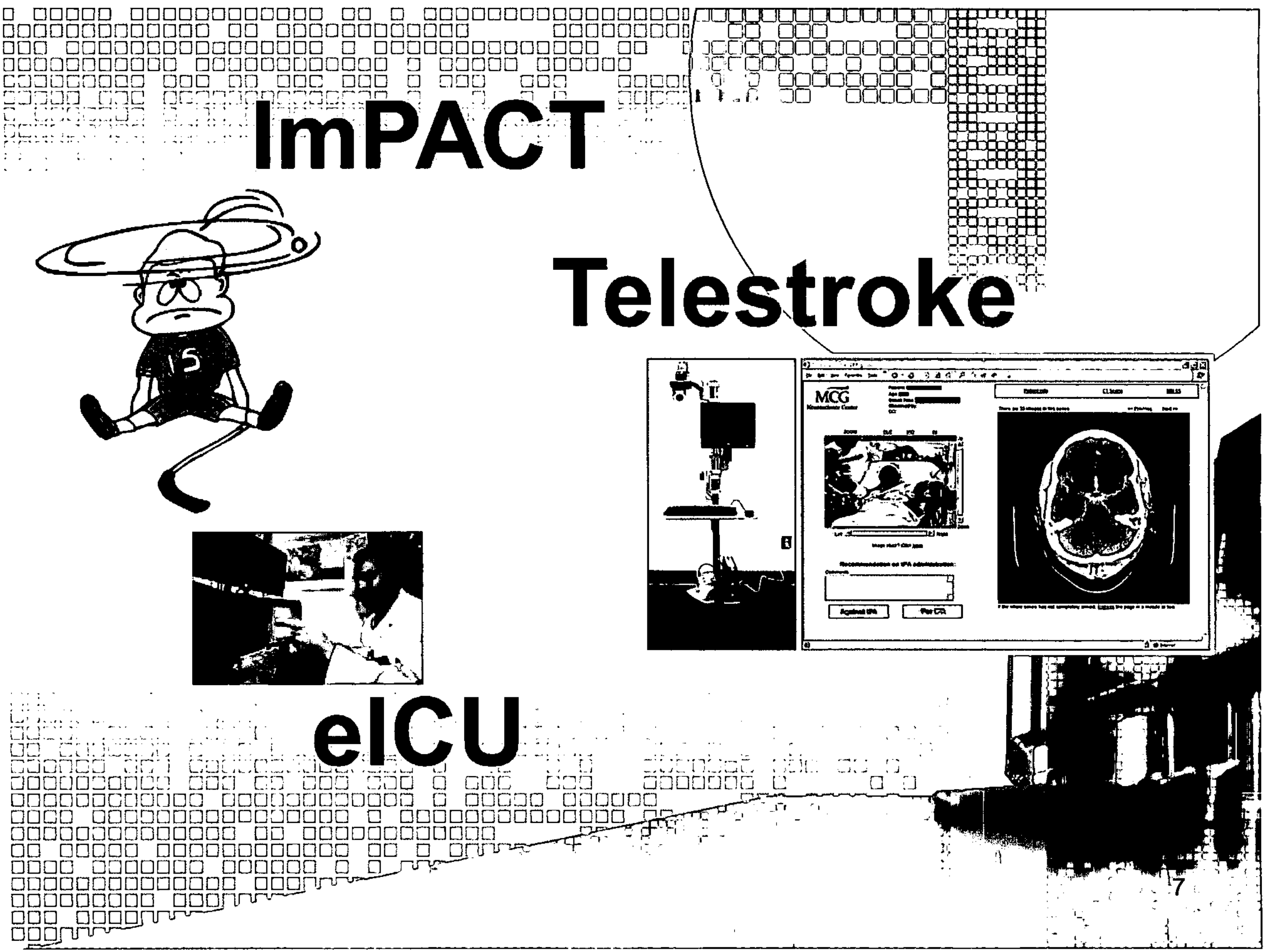
- ***Supported by technology rather than driving care delivery.***

Hospitals with multimillion-dollar information technology systems and hospitals with almost no computerization and "smart" devices at the bedside have moved toward common technology goals.

- **These goals include implementing technology and software systems that *maximize clinician time* in clinical care, are *user friendly*, increase *patient safety*, produce *positive outcomes*, and meet the goals of the *organization's strategic and business plans.***

Impact on Safety

Clinical alarms warn caregivers of immediate or potential adverse patient conditions. Alarms must be accurate, intuitive, and provide alerts that are readily interpreted and acted on by clinicians in an appropriate fashion.



1479

1480

ImPACT

- **What is a concussion?**
  - **A disturbance in brain function that occurs following either a blow to the head or as a result of the violent shaking of the head.**
- **Annual incidence of sports related concussion is ~ 300,000**
- **Approximately 20% of all athletes are likely to sustain a concussion during a given sports season**

1481

Post-Concussion Syndrome

- **Chronic cognitive and neurobehavioral difficulties related to recurrent injury**
  - **Chronic headaches**
  - **Fatigue**
  - **Sleep difficulties**
  - **Personality changes**
  - **Sensitivity to light/noise**
  - **Dizziness with standing**
  - **Deficits in short term memory, problem solving, academic functioning**
  - *Suffering a second blow while recovering from an initial concussion can be catastrophic...........*

1482

Post Concussion Recommendations

1. **No adolescent with a concussion should continue to play or return to a game after sustaining a concussion**

2. **An individual sustaining a concussion should cease doing any activity that causes the symptoms of a concussion to increase (headaches, dizziness, nausea, etc) – recovery could be delayed**

Post Concussion Recommendations

3. **School attendance and activities may need to be modified**
4. **Neuro-cognitive testing is an important component for the management of concussions**
   - **Used as one piece of the puzzle; a tool in assessing recovery from concussions and determining the timing of return to full activities**
   - **Most effective with a baseline test**

Post Concussion Recommendations

5. **No athletes should return to contact competitive sports until they are symptom free, both at rest and with exercise and have normal neuro-cognitive testing**

Post Concussion Syndrome may last for greater than a month:

- **Sleep issues**
- **Concentration and memory issues**
- **Depression and other psychiatric problems**

1485

What is ImPACT?

- User friendly, Windows-based computer program that can be administered by a team coach, athletic trainer or physician with minimum training.
- 10-modules
- Allows for an assessment of processing speed as the player fatigues
- Test takes about 20 minutes

What does ImPACT measure?

- Attention span
- Working memory
- Sustained and selective attention time
- Response variability
- Non-verbal problem solving
- Reaction time

14

1486

1487

Modules

1. **Word discrimination**
   - **Attention processes/verbal recognition**
2. **Design memory**
   - **Attention processes and visual recognition memory**
3. **X's and O's**
   - **Measures visual working memory as well as visual processing**
4. **Symbol matching**
   - **Visual processing speed, learning and memory**

1488

Modules

5. Color Match

- CHOICE REACTION TIME TASK AND MEASURES IMPULSE CONTROL/RESPONSE INHIBITION

6. Three Letters

- MEASURES WORKING MEMORY AND VISUAL-MOTOR RESPONSE SPEED

Other features...........

- Measures player symptoms
- Computer administered
- Can be administered on a lap-top
- Assists physicians and athletic trainers in making difficult return-to-play decisions
- Permits individual and group administration
- Results can be emailed or faxed for fast consultation by a neuropsychologist
- Measures attention, memory, processing speed and reaction time
- Reaction time measured to 1/100th of a second

Current Users?

- National Football League
- Major League Baseball
- Professional Automobile Racing
- National Basketball Association
- Olympic Organizations
- National Hockey League (all NHL teams)
- Junior Hockey [none in Alaska]
- Alaska Aces
- Rubgy
- Junior Soccer

Current Users?

- **Colleges / Universities**
  - **None in Alaska**
- **High Schools**
  - **Throughout the U. S.**
  - **None in Alaska**
- **Club Teams**
  - **Alyeska Ski and Snowboard Club**

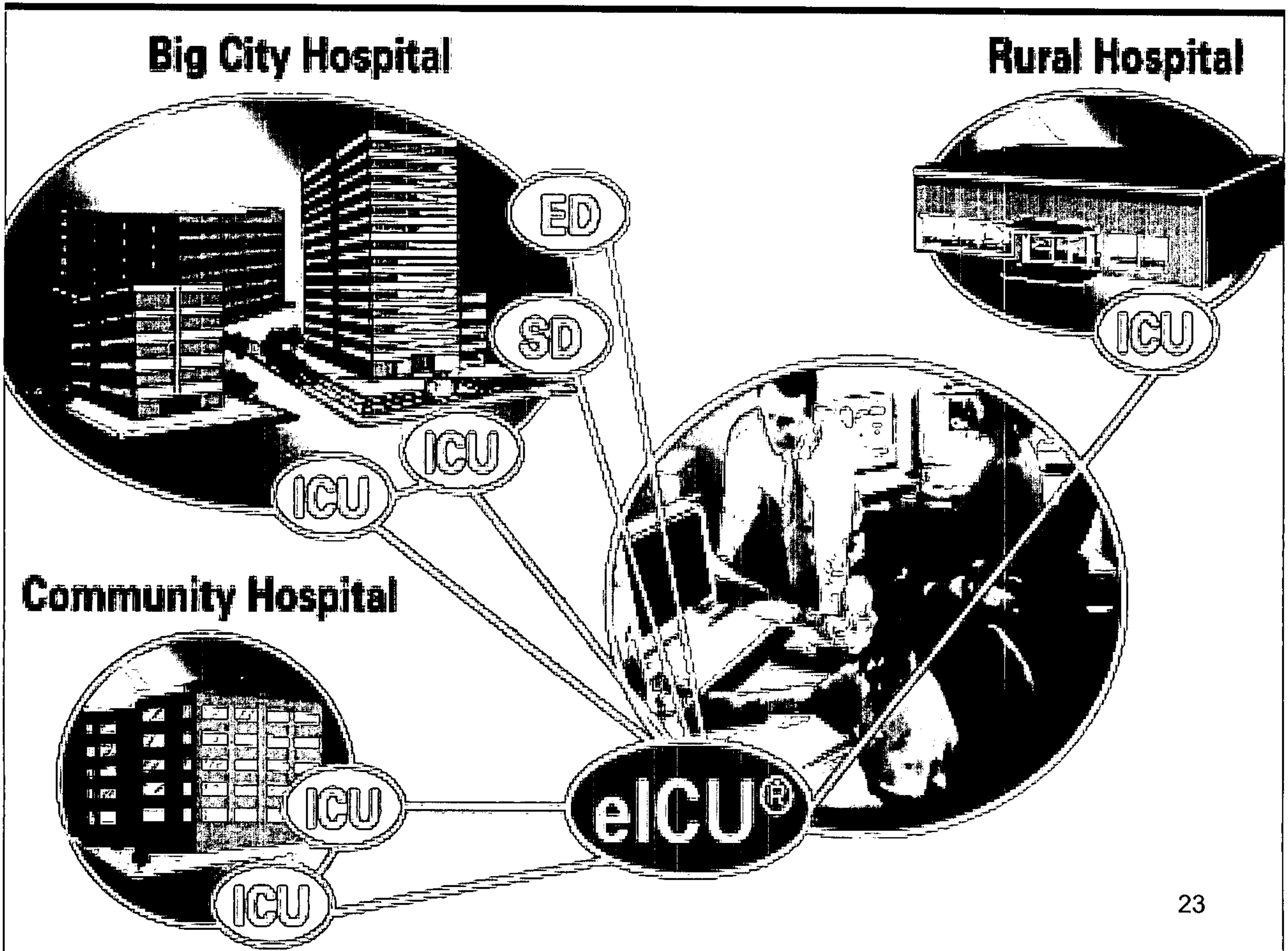
1493

eICU

The patented *e*ICU® Program allows hospitals to create a system-wide critical care program, built on a powerful technology infrastructure that improves quality, operating efficiency, and economic performance

- ***An eICU Program is staffed with an intensivist-led care team that can monitor and care for hundreds of patients much like air traffic controllers monitor hundreds of planes.***

- ***An eICU facility keeps patients safe!***


Big City Hospital
Rural Hospital
ED
SD
ICU
ICU
ICU
Community Hospital
ICU
ICU
eICU®

1495

1497

Why use technology to deliver critical care?

- Health care has safety and quality problems because it relies on outmoded systems of work
- If we want safer, higher-quality care, we will need to have redesigned systems of care
- The "Leapfrog Group" states that Intensivists should staff intensive care units

What is an eICU

- An innovative, remote-care strategy available from VISICU™, designed to improve ICU care processes while leveraging scarce intensivist resources
- Reduces clinical complications
- Has been shown to reduce mortality by more than 25%
- Combines advanced software systems and telemedicine to create a unique approach for off-site hospital personnel to deliver critical care

Delivering Stroke Care Through Technology

Ideal management of acute ischemic stroke entails the timely presentation of the patient to the hospital and a quick and efficient response on the part of the emergency medicine and neurology departments (combined with advanced and expert poststroke care in the stroke unit.

Epidemiology

- About 800,000 stroke cases are reported each year in the United States – 500,000 are new onset
- Stroke is the third leading cause of death in the United States and the 4th leading cause of death in Alaska
- Stroke is the leading cause of disability.

Significance............

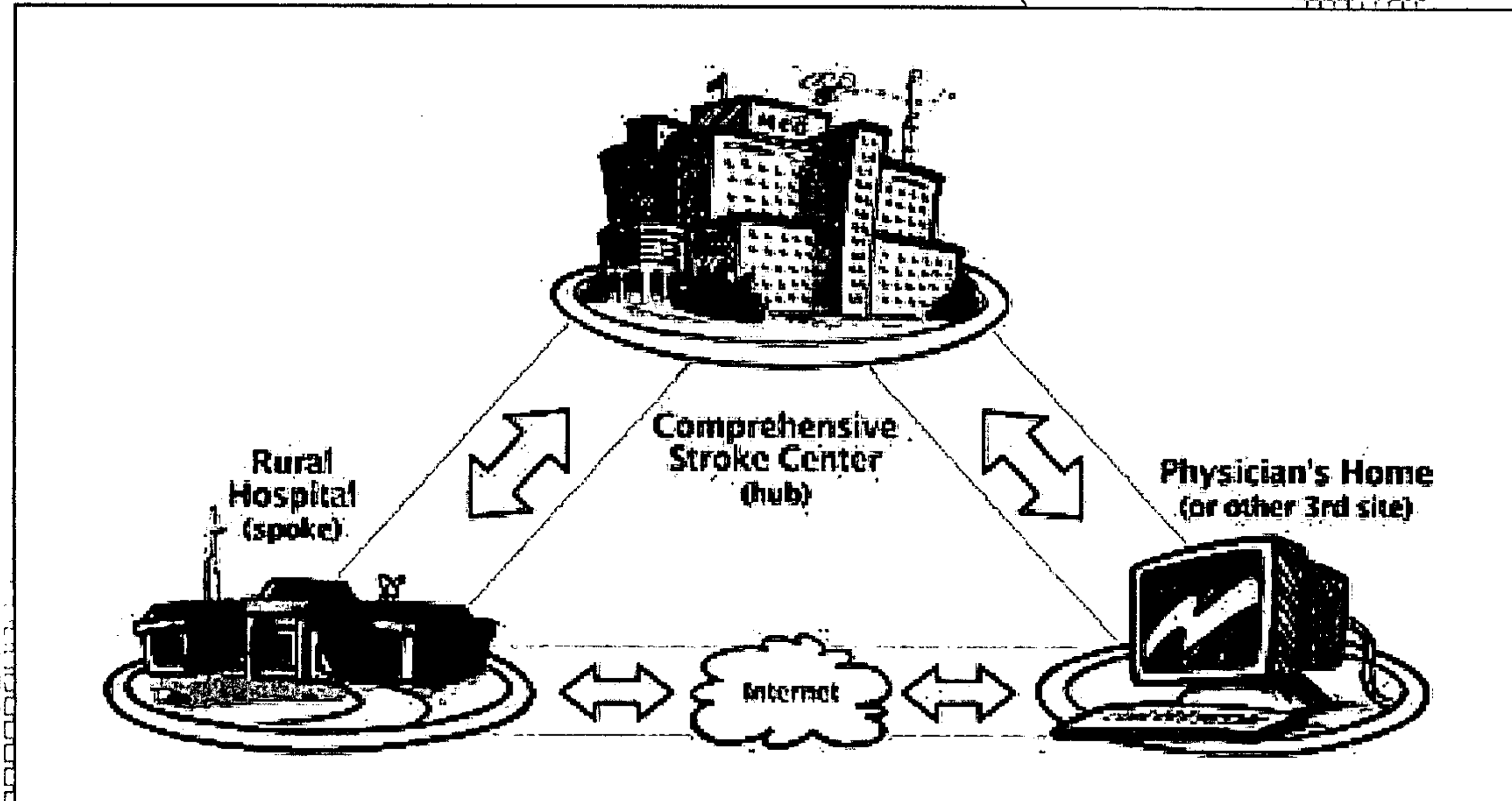
- Of all stroke survivors, 90% have permanent deficits.
- Stroke cases represent $6 billion in hospitalization costs annually.
- Total cost of stroke-related medical cost and disability in the United States was approximately $57 billion (American Stroke Association, 2005).

Stroke care in the US and in the world is fragmented and mostly unavailable in rural areas. The primary reason for poor stroke care is the lack of neurological expertise in rural hospitals.

What does Alaska look like?

- 42% hospitals have stroke protocols
- 63% have clot busting drugs
- 57% thought that telemedicine would be useful for stroke
- 84% have DICOM - CT Scanners
- Average time to CT – 30 minutes
- 63% transfer to Anchorage
- 27% transfer to Seattle

Hub and Spoke Model of Care

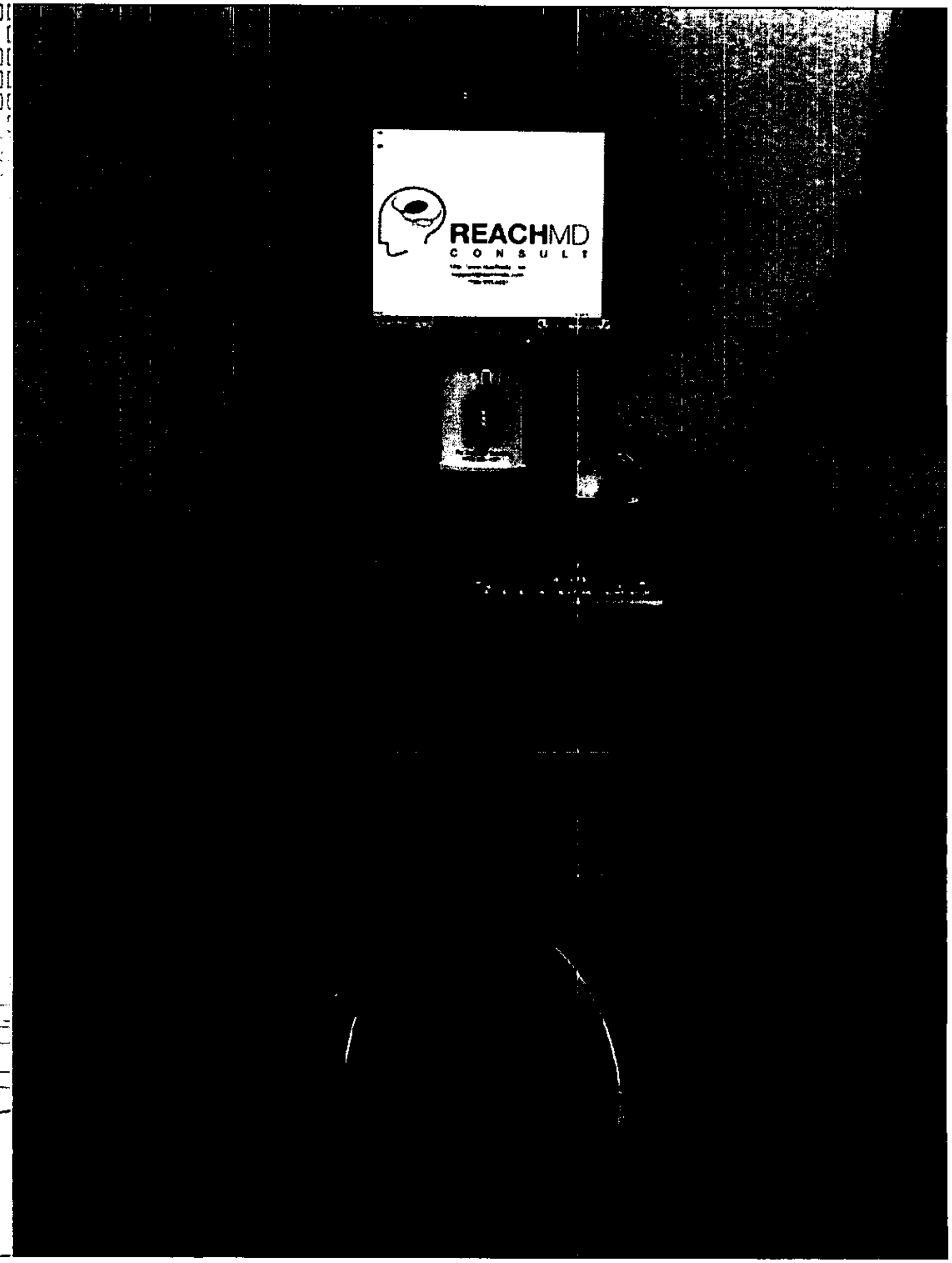


4505

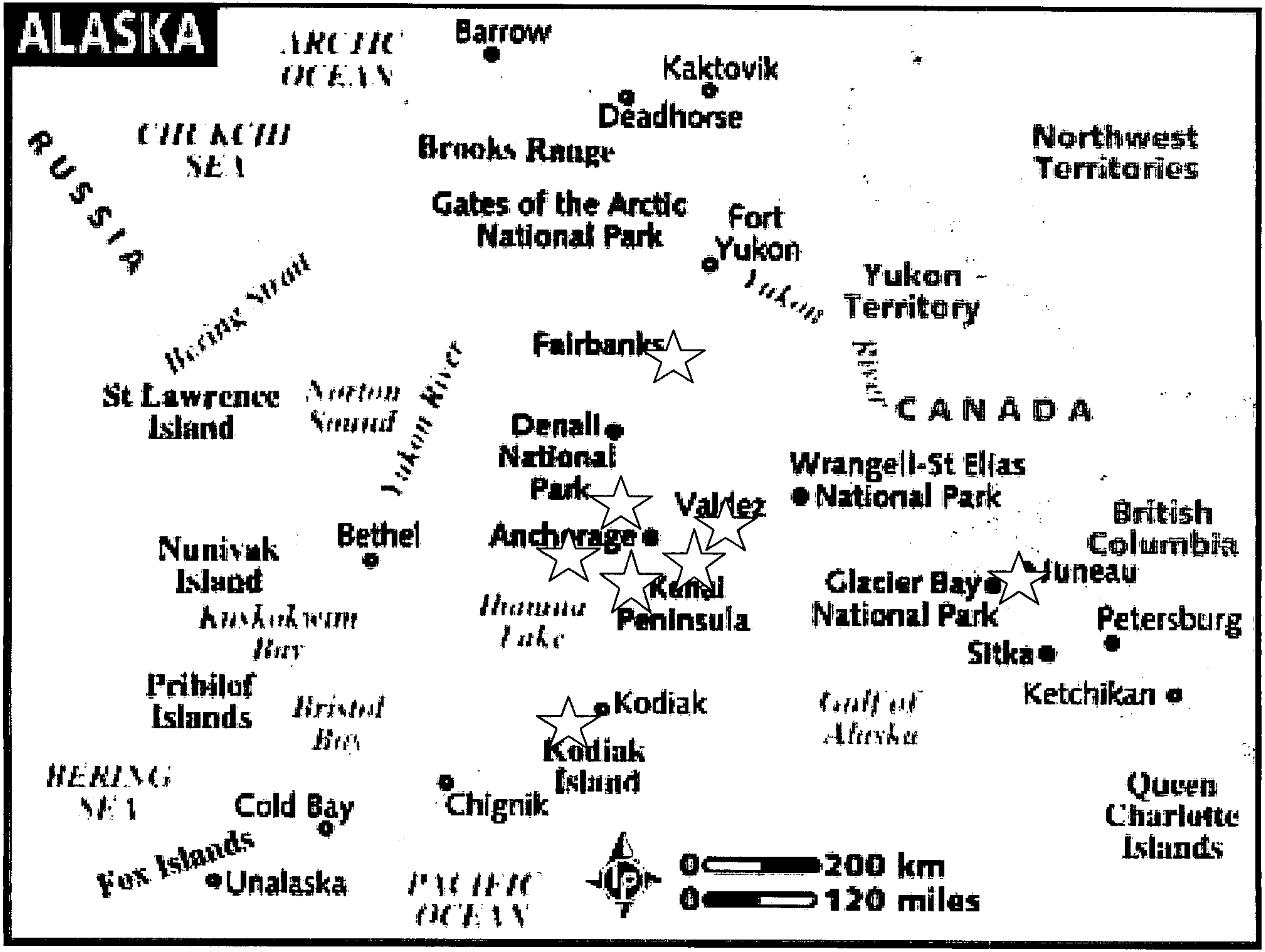
Components of a Comprehensive Stroke Center

- **Stroke Team (neurologist; neurosurgeon; specialized nursing staff; stroke unit; rehab assessment)**
- **Diagnostic radiology**
- **Specialized physicians (interventionalists; neurologists; neurosurgeons)**
- **Critical care medicine**
- **Surgical and Interventional Therapies**
- **Stroke registry**

1506



1507


ALASKA
ARCTIC OCEAN
Barrow
Kaktovik
Deadhorse
CHUKCHI SEA
RUSSIA
Brooks Range
Northwest Territories
Gates of the Arctic National Park
Fort Yukon
Yukon
Yukon Territory
Bering Strait
Fairbanks
River
St Lawrence Island
Norton Sound
Yukon River
CANADA
Denali National Park
Wrangell-St Elias National Park
Valdez
British Columbia
Bethel
Anchorage
Nunivak Island
Kenai Peninsula
Glacier Bay National Park
Juneau
Kuskokwim Bay
Iliamna Lake
Petersburg
Sitka
Pribilof Islands
Bristol Bay
Kodiak
Gulf of Alaska
Ketchikan
Kodiak Island
BERING SEA
Cold Bay
Chignik
Queen Charlotte Islands
Fox Islands
Unalaska
PACIFIC OCEAN
UP
0 200 km
0 120 miles

Benefits of Telemedicine through REACH Call, Inc.

- **Consulting Physician is Local and 100% Mobile**
- **Eliminates Travel, Saves Time and Brain!**
  - **REACHcall, Inc. eliminates the geographic penalty associated with critical care for stroke and other acute medical conditions.**
  - **Time is Brain! Time saved is Brain saved!**

Benefits of Telemedicine

- **Turnkey Service**
  - **No hardware in the Hub, Off the Shelf, Standard Hardware in the Spoke hospital.**
  - **Physicians can use their own laptop or PC at home, in their clinic or in the hospital to provide REACH consults.**
  - **Reduces Total Cost of Ownership and allows for use of better hardware without incurring huge upgrade costs**

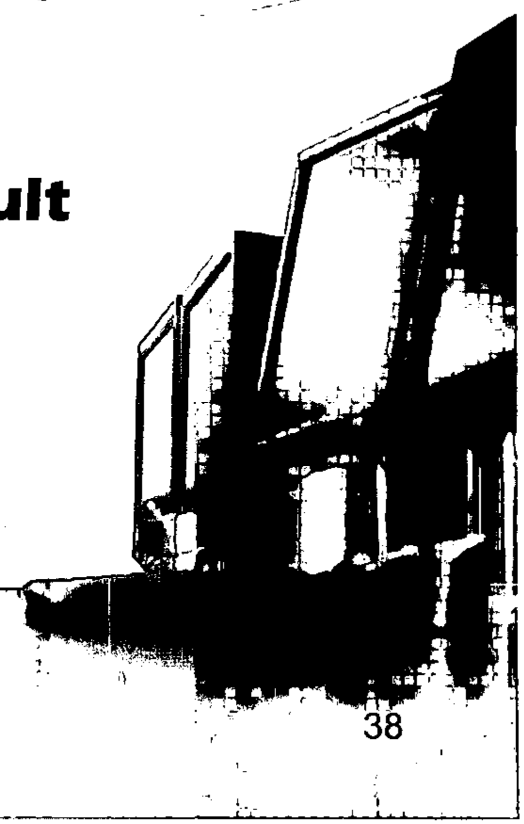
1510

- **Thin Edge, Intelligent Core Service Model**

  - **Web based access to centralized, database driven consult modules for stroke and other acute medical conditions.**

  - **On-demand, real-time access to consult reports for immediate, accurate and complete billing for hospital and physician services.**

  - **Real-time reports for measuring hospital and physician performance, optimizing treatment and standardizing critical care.**



What's next?

- **Raising the bar on care for patients with mild-moderate traumatic brain injury; critical illness, and stroke care**
- **Public awareness campaigns including prevention**
- **Media coverage**
- **Collaborative initiatives**
  - **Strategic partnerships**
  - **Shared resources**

1512

Any Questions?

SB

37

<target><bill>SB 37</bill><subject>SB 37</subject><comm>SWTR26</comm></target>

SENATE COMMITTEE REPORT
First Committee of Referral

DATE: 1/21/09

FURTHER: State Affairs
Finance

Date of 5-Day Notice: ____________
(in accordance with Uniform Rule 23)

DATE TURNED
IN TO OFFICE: 04/02/09

Senate Special Committee on World Trade, Technology, and Innovations considered SENATE BILL NO. 37

SB 37 DIVEST INVESTMENTS IN SUDAN

"An Act relating to certain investments of the Alaska permanent fund, the state's retirement systems, the State of Alaska Supplemental Annuity Plan, and the deferred compensation program for state employees in companies that do business in Sudan, and restricting those investments."

and recommends:

[ ] be **replaced** with [ ] **SCS** or [ ] **CS** ____________ (______)

[ ] adopt **previous** [ ] **SCS** or [ ] **CS** ____________ (______)

[ ] attached amendment(s)

[ ] adopt ____________ Letter of Intent

[ ] further referral to ____________ Committee

SENATE BILL:
[ ] Same Title
[ ] New Title

HOUSE BILL:
[ ] Same Title
[ ] Technical Title Change
[ ] New Title w/ SCR #_____

NEW FISCAL NOTE(S):

Department	Date	Fiscal	Indet	Zero	FN#
REV-PFC		✓			1
REV-TRS			✓		

PREVIOUS FISCAL NOTE(S):

Department	Date	Fiscal	Indet	Zero	FN#

[ ] **APPROPRIATION - no fiscal note**

SIGNATURES AND RECOMMENDATIONS:	PRINTED LAST NAME	DO PASS	DO NOT PASS	NO REC	AMEND
[signature]	Wielechowski	✓			
[signature]	Stevens	✓			
[signature]	French	✓			
CHAIR: [signature]	McGuire	✓			

1514

FISCAL NOTE

STATE OF ALASKA
2009 LEGISLATIVE SESSION

Fiscal Note Number: 1
Bill Version: **SB 37**
() Publish Date:

Identifier (file name):	SB37-REV-APFC-03-30-09	Dept. Affected:	Revenue
Title	DIVEST INVESTMENTS IN SUDAN	RDU	AK Permanent Fund Corporation
		Component	AK Permanent Fund Corporation
Sponsor	Senator French		
Requester	Senate World Trade, Tech, Innovations	Component Number	109

Expenditures/Revenues (Thousands of Dollars)

Note: Amounts do not include inflation unless otherwise noted below.

	Appropriation Required	Information					
OPERATING EXPENDITURES	**FY 2010**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
Personal Services							
Travel							
Contractual	20.0		20.0	20.0	20.0	20.0	20.0
Supplies							
Equipment							
Land & Structures							
Grants & Claims							
Miscellaneous	30.0		30.0	30.0	30.0	30.0	30.0
TOTAL OPERATING	**50.0**	**0.0**	**50.0**	**50.0**	**50.0**	**50.0**	**50.0**
CAPITAL EXPENDITURES							
CHANGE IN REVENUES ( )							

FUND SOURCE (Thousands of Dollars)

1002 Federal Receipts							
1003 GF Match							
1004 GF							
1005 GF/Program Receipts							
1037 GF/Mental Health							
1105 APFC Receipts	50.0		50.0	50.0	50.0	50.0	50.0
TOTAL	**50.0**	**0.0**	**50.0**	**50.0**	**50.0**	**50.0**	**50.0**

Estimate of any current year (FY2009) cost: 30.0

POSITIONS

Full-time							
Part-time							
Temporary							

ANALYSIS: *(Attach a separate page if necessary)*

This bill would require that APFC divest any securities of publicly traded companies that are directly held in actively or passively managed separate (non-commingled) funds. This bill would also require that APFC send letters to managers of actively traded commingled funds requesting that they consider divesting the listed securities. APFC is directed to develop a divestment list: administrative cost of purchasing lists of publicly traded companies doing business in Sudan from external sources each year as part of research process totals $30.0. Active separate account managers have stated that they will not charge customization fees. Stated customization charge in addition to regular management fees for passive accounts (as of Jan 2009) of $20.0.

Prepared by: Michael J. Burns — Phone 907-796-1520
Division: Alaska Permanent Fund Corporation — Date/Time March
Approved by: — Date

(Revised 9/10/2008 OMB)

1515

FISCAL NOTE

STATE OF ALASKA
2009 LEGISLATIVE SESSION

Fiscal Note Number:
Bill Version: SB 37
() Publish Date:

Identifier (file name):	SB37-DOR-TRS-03-30-09	Dept. Affected:	Revenue
Title	Sudan Divestiture	RDU	Treasury
		Component	ARMB/ARMB Custody/Treasury
Sponsor	Senator French		
Requester	Senate World Trade, Technology and Innovation	Component Number	2813/2812/121

Expenditures/Revenues (Thousands of Dollars)

Note: Amounts do not include inflation unless otherwise noted below.

	Appropriation Required	Information					
OPERATING EXPENDITURES	**FY 2010**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
Personal Services							
Travel							
Contractual							
Supplies							
Equipment							
Land & Structures							
Grants & Claims							
Miscellaneous							
TOTAL OPERATING	***	***	***	***	***	***	***
CAPITAL EXPENDITURES	***	***	***	***	***	***	***
CHANGE IN REVENUES ( )	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

FUND SOURCE (Thousands of Dollars)

1002 Federal Receipts							
1003 GF Match							
1004 GF							
1005 GF/Program Receipts							
1037 GF/Mental Health							
Other Interagency Receipts							
TOTAL	***	***	***	***	***	***	***

Estimate of any current year (FY2009) cost:

POSITIONS

Full-time	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Part-time	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temporary	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ANALYSIS: *(Attach a separate page if necessary)*

This bill requires the fiduciaries of state investment funds to divest of certain investments in publicly traded companies that conduct business operations or have direct investments in business operations in Sudan. While Treasury believes that active and passive separate account managers will not charge additionally for divestment, Treasury does not believe that mangers of passive commingled funds will be able to comply with the divestment policy and that Sudan-free replacement funds will need to be identified. Currently, there are 25 funds (primarily participant directed funds) that would need to be replaced. Costs for conducting a search for a single fund is approximately $25,000, although multiple fund searches would result in reduced costs. Other costs to be considered would include the opportunity cost of staff time to implement new contracts and any cost impact resulting from introducing additional plan options to participants. The effect this bill will have on investment performance is unknown.

Prepared by:	Pamela Green, Comptroller	Phone	465-2300
Division	Treasury Division	Date/Time	1/23/09 12:00 AM
Approved by:	Jerry Burnett, Deputy Commissioner	Date	3/30/2009
	Department of Revenue		

Alaska State Legislature

Senator Hollis French

SB 37 - Divest Investments in Sudan

Sponsor Statement

Government supported genocide has killed hundreds of thousands of people and displaced approximately 2.5 million residents from the Darfur region of Sudan. This legislation will enact a targeted divestment program that prevents the state of Alaska from investing Permanent Fund and retirement plan dollars in companies that directly finance genocide in Darfur. SB 37 gives Alaska the opportunity to join the states, businesses and educational institutions that refuse to fund such atrocities.

Targeted divestment is a proven tactic to reduce the viability of genocide in Darfur. Twenty seven other states have divested from businesses that operate in the region. The cost to these states has been negligible. Institutions have found no noticeable decrease in returns when divestment only targets companies that have explicit financial links to the conflict. Holdings in these companies amount to seven investments valued at less than 0.1% of all Permanent Fund assets, showing that the implementation of this legislation will not require a major shift in investment strategy.

Results from the divestment movement have been promising. Sudan, unlike many foreign governments that sponsor genocide, has responded favorably when threatened with economic sanctions. Partly as a result of the divestment movement, the Sudanese government purchased a six-page, $1 million advertisement in the New York Times that sought out foreign direct investment. As more companies pull out of the region or encourage the government of Sudan to halt violent acts, the end of genocide is highly probable.

Ignoring genocide has left several scars on recent American history. With the cost of action so small, Alaska has no excuse to sit on the sidelines. I urge you to support this important and meaningful piece of legislation.

SB 37 Short Sectional Summary:

Section 1 of the bill **(Page 1 lines 6-14)** applies Section 2 of this bill to the obligations of the Alaska Retirement Management Board

Section 2 of the legislation **(starting on Page 2 line 1)** outlines how the board will identify, notify and, if necessary, divest funds from scrutinized companies.

Subsection (a) **(Page 2 line 3)** describes how the board shall identify scrutinized businesses. It includes numerous routes to create a list, and the definition of 'scrutinized business' will be discussed in more detail later in the bill.

Subsection (b) **(Page 2 line 18)** provides some examples of companies that aren't to be included on this scrutinized company list. As examples, businesses that have a plan to cease offending business operations in the country, or that have taken actions to support people affected by the genocide, will not be added to the scrutinized business list.

Subsection (c) **(Page 3 line 7)** requires that the board notify these scrutinized companies.

Subsection (d) **(Page 3 line 22)** provides for divestment from scrutinized companies that have active business operations in the state that do not divest within 90 days of notification from the board, as defined in subsection (c).

Subsection (e) **(page 3 line 30)** deals with companies that have inactive business operations in Sudan. 'Inactive business operations' are defined in section (h), page 5 line 4, as continued holding or the renewal of rights to property in Sudan that isn't currently generating revenue.

Subsection (f) **(page 4 line 9)** establishes reporting requirements to the legislature and other agencies.

Subsection (g) **(page 4 line 13)** says that this legislation prevails when it conflicts with the outlined investment policy in statute for the permanent fund.

Subsection (h) **(page 4 line 17)** provides definitions. The longest one **(page 5 line 27 through page 6 line 23)** defines 'scrutinized companies,' and ensures that this legislation won't include a broad list of businesses. Scrutinized companies only include businesses that have direct contractual agreements with the government of Sudan, that include oil and power production, supplying military equipment, or that are actively involved with supporting genocide actions. An 'out' exists for companies or projects that support or provide assistance to marginalized populations in the country. This definition of 'scrutinized company' is very limited, and in general practice includes only a few dozen companies.

Section 3 of the bill **(Page 6 line 24)** terminates the divestment program once certain benchmarks are met, such as the end of violence.

FISCAL NOTE

STATE OF ALASKA
2009 LEGISLATIVE SESSION

Fiscal Note Number:
Bill Version: **SB 37**
() Publish Date:

Identifier (file name): SB37-DOR-TRS-03-30-09
Title: Sudan Divestiture
Sponsor: Senator French
Requester: Senate World Trade, Technology and Innovation

Dept. Affected: Revenue
RDU: Treasury
Component: ARMB/ARMB Custody/Treasury
Component Number: 2813/2812/121

Expenditures/Revenues (Thousands of Dollars)

Note: Amounts do not include inflation unless otherwise noted below.

	Appropriation Required	Information					
OPERATING EXPENDITURES	**FY 2010**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
Personal Services							
Travel							
Contractual							
Supplies							
Equipment							
Land & Structures							
Grants & Claims							
Miscellaneous							
TOTAL OPERATING	***	***	***	***	***	***	***
CAPITAL EXPENDITURES	***	***	***	***	***	***	***
CHANGE IN REVENUES ( )	0.0	0.0	0.0	0.0	0.0	0.0	0.0

FUND SOURCE (Thousands of Dollars)

1002 Federal Receipts							
1003 GF Match							
1004 GF							
1005 GF/Program Receipts							
1037 GF/Mental Health							
Other Interagency Receipts							
TOTAL	***	***	***	***	***	***	***

Estimate of any current year (FY2009) cost:

POSITIONS

Full-time	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Part-time	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temporary	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ANALYSIS: *(Attach a separate page if necessary)*

This bill requires the fiduciaries of state investment funds to divest of certain investments in publicly traded companies that conduct business operations or have direct investments in business operations in Sudan. While Treasury believes that active and passive separate account managers will not charge additionally for divestment, Treasury does not believe that mangers of passive commingled funds will be able to comply with the divestment policy and that Sudan-free replacement funds will need to be identified. Currently, there are 25 funds (primarily participant directed funds) that would need to be replaced. Costs for conducting a search for a single fund is approximately $25,000, although multiple fund searches would result in reduced costs. Other costs to be considered would include the opportunity cost of staff time to implement new contracts and any cost impact resulting from introducing additional plan options to participants. The effect this bill will have on investment performance is unknown.

Prepared by: Pamela Green, Comptroller — Phone 465-2300
Division: Treasury Division — Date/Time 1/23/09 12:00 AM
Approved by: Jerry Burnett, Deputy Commissioner, Department of Revenue — Date 3/30/2009

(Revised 9/10/2008 OMB)

FISCAL NOTE

STATE OF ALASKA
2009 LEGISLATIVE SESSION

Fiscal Note Number: 1
Bill Version: **SB 37**
() Publish Date:

Identifier (file name): SB37-REV-APFC-03-30-09
Dept. Affected: Revenue
Title: DIVEST INVESTMENTS IN SUDAN
RDU: AK Permanent Fund Corporation
Component: AK Permanent Fund Corporation
Sponsor: Senator French
Requester: Senate World Trade, Tech, Innovations
Component Number: 109

Expenditures/Revenues (Thousands of Dollars)

Note: Amounts do not include inflation unless otherwise noted below.

	Appropriation Required	Information					
OPERATING EXPENDITURES	**FY 2010**	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
Personal Services							
Travel							
Contractual	20.0		20.0	20.0	20.0	20.0	20.0
Supplies							
Equipment							
Land & Structures							
Grants & Claims							
Miscellaneous	30.0		30.0	30.0	30.0	30.0	30.0
TOTAL OPERATING	**50.0**	**0.0**	**50.0**	**50.0**	**50.0**	**50.0**	**50.0**
CAPITAL EXPENDITURES							
CHANGE IN REVENUES ( )							

FUND SOURCE (Thousands of Dollars)

1002 Federal Receipts							
1003 GF Match							
1004 GF							
1005 GF/Program Receipts							
1037 GF/Mental Health							
1105 APFC Receipts	50.0		50.0	50.0	50.0	50.0	50.0
TOTAL	**50.0**	**0.0**	**50.0**	**50.0**	**50.0**	**50.0**	**50.0**

Estimate of any current year (FY2009) cost: 30.0

POSITIONS

Full-time							
Part-time							
Temporary							

ANALYSIS: *(Attach a separate page if necessary)*

This bill would require that APFC divest any securities of publicly traded companies that are directly held in actively or passively managed separate (non-commingled) funds. This bill would also require that APFC send letters to managers of actively traded commingled funds requesting that they consider divesting the listed securities. APFC is directed to develop a divestment list: administrative cost of purchasing lists of publicly traded companies doing business in Sudan from external sources each year as part of research process totals $30.0. Active separate account managers have stated that they will not charge customization fees. Stated customization charge in addition to regular management fees for passive accounts (as of Jan 2009) of $20.0.

Prepared by: Michael J. Burns
Phone 907-796-1520
Division: Alaska Permanent Fund Corporation
Date/Time March
Approved by:
Date

(Revised 9/10/2008 OMB)

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SUDAN DIVESTMENT

TASK FORCE

A project of the Genocide Intervention Network

EFFICACY OF TARGETED DIVESTMENT: AT A GLANCE

The government of Sudan has been historically responsive to economic pressure.

US sanctions declared in 1997 caused the Sudanese government to drop its support for terror and cooperate with the US on counter-terrorism. The emerging Sudan divestment movement has already caught the attention of the Sudanese government, which has spent considerable time and energy attacking the campaign, even going so far as to purchase a six page ad for more than $1 million in the New York Times to counteract the divestment movement. Unlike isolated countries that tend to shrug off sanctions, the Sudanese government is desperately trying to attract foreign investment. Threats to these efforts are taken very seriously by Sudan.

Divestment makes genocide costly.

Under current political and diplomatic pressure the Sudanese government incurs virtually no cost for continuing its genocide in Darfur, beyond further damage to its image in the West. Divestment, however, forces the Sudanese government to pay a price for its refusal to restore peace and security to Darfur.

Widespread divestment causes share price depreciation.

While the effect of divestment on offending companies' share prices thus far remains unclear, the divestment movement is spreading with enormous speed, both in the US and internationally. It is only a matter of time before enough assets have been divested to actually make a substantial impact on share prices. There is precedent for share price depreciation vis-à-vis a previous Sudan divestment campaign—Talisman Energy's share price was estimated to have dropped roughly a third on account of the divestment campaign against it.

Foreign direct investment enables the Sudanese government to carry out genocide in Darfur.

Recent increases in foreign direct investment in Sudan, particularly in the oil industry, have disproportionately benefited Sudan's military and elite. Since oil was first extracted in 1999, Sudan's military budget has more than doubled. It is estimated that 70-80% of oil revenue is now funneled into Sudan's military.

The Sudanese government is paying attention to the divestment movement.

The Sudanese embassy authored a press release and an op-ed condemning divestment, and the Sudanese ambassador actually spoke by phone with activists in an attempt to discourage divestment. The Sudanese government even took out a six-page ad in the New York Times this past March extolling Sudan as a peaceful country worthy of foreign direct investment.

Companies in Sudan are already responding to shareholder pressure.

CHC Helicopter Corporation, the world's largest provider of helicopter services to the global offshore oil and gas industry and previously a highly scrutinized company in Sudan, recently ceased all business operations in Sudan for the indefinite future after substantial levels of inquiry from a range of concerned investors. Another firm operating in Sudan and an S&P 500 company, Schlumberger, which provides oil-field services to the major oil consortiums in Sudan, has committed to reinforcing its existing outreach programs by implementing substantial humanitarian programs to reach marginalized populations in the country.

Also this year, Rolls Royce PLC, which sells oil-engineering equipment, announced its decision to leave Sudan citing "increasing international humanitarian concerns about the situation in Darfur." Additionally, Swiss power giant ABB announced its decision to suspend all non-humanitarian operations in Sudan--a decision in which divestment played a partial role. Shortly thereafter, one of Germany's largest companies, Siemens, pledged to pull out of the country, also citing the pressure created by divestment as a factor.

SUDAN DIVESTMENT
TASK FORCE
A project of the Genocide Intervention Network

Some American firms exempted from US sanctions, including Xerox and 3M, have decided to curtail all non-humanitarian operations in the country. Companies have also begun to go so far as to list the divestment movement as a potential concern on SEC filings. Finally, in a clear sign of concern, companies tied to Sudan have spent increasing amounts on political contributions to Congressional leaders who are supporting Sudan divestment legislation.

Sudan divestment keeps the media focused on Darfur.

Divestment continues to keep Darfur in the public eye and sends a clear message to both the Federal government and the international community that the crisis warrants attention. Additionally, the divestment campaign highlights the role that foreign corporations and governments play in sustaining the genocidal policies of the government of Sudan. Coverage for divestment has appeared in the New York Times, Wall Street Journal, Washington Post, International Herald Tribune, LA Times, BBC, Financial Times, NPR, Christian Science Monitor, and many other media outlets. See www.sudandivestment.org/inthenews.asp for a representative listing.

Targeted Divestment: Supported by Foreign Policy and Financial Experts

Prominent foreign policy experts and think tanks which do not classically support blanket sanctions, including experts from the International Crisis Group, Harvard University, the Heritage Foundation, and former UN Envoy to Sudan, Jan Pronk, have all endorsed targeted sanctions, including divestment, on the Sudanese regime calling it a critical tool for influencing the behavior of the Sudanese government and bringing long-term peace and security to the region. In March 2007, the *Associated Press* reported that opposition leaders in Sudan have also expressed support for targeted sanctions on the Khartoum government. Finally, a number of Sudan experts from around the globe have pointed to targeted divestment as a financially prudent strategy for helping to stop genocide in Darfur.

International Crisis Group
"The [targeted Sudan divestment] campaign should be encouraged, including by naming and shaming companies, and copied in other countries."

Roberta Cohen -- Senior Advisor, The Brookings Institution
"In the view of some analysts, divestment campaigns may prove more effective than sanctions. Rolls Royce's withdrawal from Sudan this past year reportedly surprised the government and affected the import of needed machine parts. The Sudanese government has publicly urged an end to divestment actions, underscoring the potential sting of their impact."

UN Human Rights Council
"...the General Assembly should call upon all UN institutions and offices to abstain from entering into business transactions with [foreign companies that have an adverse impact on the situation of human rights in Darfur]."

Joseph Stiglitz - Nobel Prize Winner and Trustee of Amherst College
"The government does not have a heavy development agenda--it's not as though the government is busy building schools in Darfur. It's a pretty clear case of this money being used against the government's own people."

Alfred Taban, editor of the independent newspaper, the Khartoum Monitor
"[Sudanese officials are] very worried about such sanctions. They get a lot of money from these companies."

A Coalition 15 Former European, Canadian, and US Foreign Ministers
"If by the end [of 2006]. Mr Bashir still refuses or, more likely, continues pretending to agree one day and saying no the next, he should pay a stiff price. That price should include...measures to target revenue from Sudan's oil sales."

For a full report on the efficacy of targeted divestment and complete references, visit www.sudandivestment.org/position.asp.

LEGISLATIVE RESEARCH REPORT

JANUARY 22, 2009 REPORT NUMBER 09.096

DIVESTMENT OF QUALIFYING COMPANIES OPERATING IN SUDAN FROM ALASKA PUBLIC FUNDS

BY DANIEL LESH, LEGISLATIVE ANALYST

You asked about state economic sanctions against the government of Sudan via the divestment of public assets in certain companies. Specifically, you asked for a review of relevant U.S. state laws and a description of the potential effects of a "targeted divestment" law on the State of Alaska with respect to the Alaska Permanent Fund and other Alaska state funds.

SUMMARY

As of January 21st, 2009, at least 31 states have adopted or are considering implementing policies to divest state assets from Sudan, where the U.S. Congress has declared that genocide is taking place. Twenty-seven of these states have enacted divestment policies. By our calculation, as of December 31st, 2008, state investments totaling roughly $19.6 million would be subject to divestment under legislation currently introduced in Alaska (HB 5, HB 45, SB 37). If any one of these bills became law, divestment of these assets would be accomplished over an 18-month period and would incur additional administrative costs. The direct impacts of divestment on the state's investment earnings, as well as on targeted companies, are debatable, but in both cases would likely be minimal.

STATUS OF STATE DIVESTMENT LEGISLATION

As of January 21st, 2009, at least 31 states have adopted or are considering implementing policies to divest state assets from Sudan, where the U.S. Congress has declared that genocide is taking place.[1] Lawmakers in 20 states have enacted laws that require state funds to divest holdings in some or all companies operating in Sudan. Seven additional states have adopted

[1] Data on state legislation are from *Lexis.com* and the Sudan Divestment Task Force's chart of "Divestment Statistics" (Attachment A).

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similar policies through their executive branches. Louisiana's legislature has passed a law encouraging divestment, but state officials do not appear to be following this recommendation. Lawmakers in another three states are considering measures that address divestment from Sudan. Please see Table 1 for details on Sudan divestment legislation in each of these states.

The laws and pending legislation listed in Table 1 generally follow one of two models. Of the 31 divestment policies, 21—including the policy proposed in Alaska—follow a targeted approach that is applicable only to specific types of foreign companies operating in Sudan.[2] A targeted approach relies on the creation and maintenance of lists of companies that are deemed to be supporting the genocide in Sudan. Most of the targeted companies participate in Sudan's oil industry and pay taxes and royalties that fund the Sudanese government.

States that do not follow a targeted divestment approach prohibit investment in any company operating in Sudan, though generally with an exception for humanitarian and various other types of organizations. A number of states (Colorado, Florida, Georgia, Kentucky, Louisiana, Maryland, and Missouri) have also included other countries, such as Iran, North Korea, and Syria, in their divestment policies.

On December 31st, 2007, President Bush signed the Sudan Accountability and Divestment Act, which authorizes—but does not require—state and local governments to disassociate from companies operating in Sudan and prohibits the granting of new federal contracts to those foreign companies.

As you may know, no domestic companies are affected by state divestment laws, because U.S. companies are prohibited from operating in Sudan by federal executive orders dating from 1997.[3]

[2] Targeted divestment is advocated by the Sudan Divestment Task Force (SDTF), a prominent organization in this area. We include their model legislation as Attachment B and apply its provisions—which are substantially the same as those introduced in Alaska—in this report.

[3] Executive Orders 13067 (1997), 13400 (2006), and 13412 (2006).

Table 1: Status of State Legislation Related to Divestment of Public Funds from Sudan		
State	**Citation**	**Pending Legislation**
	Targeted divestment measure	
Alaska		HB 5, HB 45, SB
Arizona	Ariz. Rev. Stat. § 35-391 (2008)	
California	Cal. Gov. Code § 7513.6 (2007)	
Colorado	Colo. Rev. Stat. § 24-54.8 (2007)	
Florida	Fla. Stat. § 215.473 (2007)	
Hawaii	Act No. 192, Session Law 2007	
Indiana	Ind. Code. Ann. § 5-10.2-9	
Iowa	Iowa Code § 12F (2007)	
Kansas	Kan. Stat. Ann. § 74-4923 and 74-4960 (2007)	
Massachusetts	Chapter 151, Session Law 2007	
Michigan	Mich. Comp. Laws Ann. § 38.1133 (2008)	
Minnesota	Minn. Stat. § 11A.243 (2007)	
Nebraska		LB 140
New Hampshire	N.H. Rev. Stat. Ann. § 100-D (2008)	
New Mexico	Executive Branch Policy	
New York	Executive Branch Policy	
North Carolina	N.C. Gen. Stat. § 147-86 (2008)	
Ohio	Executive Branch Policy	
South Carolina	S.D. Codified Laws § 9-16-55 (2008)	
Texas	Tex. Govt Code Ann. § 806.001 (2007)	
Vermont	Executive Branch Policy	
	Non-targeted (blanket) divestment measure	
Georgia		HB 99
Illinois[(a)]	40 Ill. Comp. Stat. 5/1-110.6 (2007)	
Maine	Me. Rev. Stat. Ann. tit. 5, § 1956 (2007)	
Maryland	Md. Code Ann. § 21-123.1 (2008)	
Missouri	Executive Branch Policy	
New Jersey	N.J. Stat. Ann. § 52:18A-89.9 (2007)	
Oregon	Or. Rev. Stat. § 293.811-817 (2006)	
	Non-binding measures encouraging divestment	
Arkansas[(b)]	SCR 20 & Executive Branch Policy	
Connecticut[(b)]	Conn. Gen. Stat. § 3-21e (2007) & Executive Branch Policy	
Louisiana	La. Rev. Stat. Ann. § 11:312 (2007)	

NOTES: Pending legislation in some states may not have been captured by our search and this list should not be treated as exhaustive. (a) Illinois' 2007 legislation replaced the state's 2005 law, which was found unconstitutional. (b) Laws in Arkansa and Connecticut are non-binding, but the states have divested significant assets. **SOURCES:** *Lexis.com*; Sudan Divestment Task Force's "Divestment Statistics" chart (Attachment A).

The state of Alaska maintains invested assets totalling about $60 billion dollars.[4] Of these investments, a small portion (about $20 million) would be subject to divestment under a targeted approach.[5] As of December 31st, 2008, we calculate that a maximum of about $15.8 million in Permanent Fund investments (about 0.05% of the $29.7 billion market value of the fund at that time) would require divestment using the Sudan Divestment Task Force's list of targeted companies (see Table 2). In addition, we identified about $3.8 million in other state assets that would be targeted for divestment, using a list of holdings also current through December 31st, 2008.

Table 2: Alaska Permanent Fund and Other State Stock Holdings Subject to Divestment

Company	Market Value		Country
Permanent Fund			
China Petroleum (Petrochina)	$	14,353,173	China
Dongfeng Automodile Company Limited	$	1,302,581	China
Wartsila	$	93,466	Finland
Lundin Petroleum	$	44,681	Sweden
TOTAL FOR PERMANENT FUND	$	15,793,900	
Other State Funds Managed by Division of Treasury			
Alstom	$	1,596,456	France
Abb	$	1,216,860	Switzerland
Wartsila	$	987,127	Finland
TOTAL FOR OTHER STATE FUNDS	$	3,800,443	
GRAND TOTAL	**$**	**19,594,343**	

NOTES: Data current as of December 31, 2008. Holdings subject to divestment determined using the Sudan Divestment Task Force's (SDTF) divestment lists. Some of the stocks listed above may be indirect holdings in actively managed investment funds, which are exempt from divestment under the SDTF targeted divestment model applied in this report.
SOURCES: Alaska Permanent Fund holdings obtained from the fund's website, *http://www.apfc.org/*. Data on stock holding sin other state funds obtained from Pam Green, state comptroller, Department of Revenue, (907) 465-3751.

[4] As of November 30th, 2008—the most recent date for which these data are available—the state's investments include the following: the Alaska Permanent Fund ($28.9 billion); funds under the fiduciary responsibility of the Alaska Retirement Management Board, including the Public Employees' Retirement System ($8.6 billion), Teachers' Retirement System ($3.9 billion), Judicial Retirement System ($0.1 billion), National Guard/Naval Militia Retirement System funds ($.02 billion), Supplemental Benefits System funds ($1.8 billion), and Alaska Deferred Compensation Plan funds ($0.4 billion); funds under the fiduciary responsibility of the Commissioner of the Department of Revenue, including the General Fund and other Non-segregated Investments (GeFONSI; $7.8 billion), Constitutional Budget Reserve Fund ($6.1 billion), and other funds ($1.3 billion; including the Public School Trust Fund, Alaska Children's Trust, Investment Loss Trust Fund, General Obligation Bonds, International Airports funds, Retiree Health Insurance Fund, Power Cost Equalization Endowment Fund, Illinois Creek Mine Restoration Fund, Permanent Fund Dividend Fund, and Alaska Sport Fish Construction Fund); and other state funds ($0.2 billion; including the University of Alaska Trust Fund, Alaska Student Loan Corporation funds, Exxon Valdez Oil Spill Investment Fund, and Mental Health Trust Reserve Fund). Information on state funds obtained from a Department of Revenue table, which we include as Attachment C.

[5] Only the portions of funds with publicly-traded equity would be affected, which for these funds is typically a small proportion of total investments. Furthermore, the targeted approach we apply here includes an exception for indirect holdings in actively managed, commingled investment funds—the most difficult and expensive type of fund to customize.

Under the targeted divestment bills currently under consideration in Alaska (HB 5, HB 45, SB 37), divestment of the assets described in Table 2 would occur over an 18-month period following the effective date of the legislation. In the first step of the process, fund directors would be allowed 90 days to compile and adopt a "scrutinized companies list" based on criteria and sources outlined in the legislation. Following adoption of the list, funds would be required to contact all scrutinized companies in which they have direct holdings and allow them 90 days to change their offending operations before becoming subject to divestment.[6] Within nine months of the adoption of the "scrutinized companies list," funds would be required to complete the divestment of 50 percent of holdings in scrutinized companies. Within 15 months, 100 percent of holdings in scrutinized companies would be required to be divested. Funds would not be required to divest indirect, actively managed holdings. This timeframe is within that described by Alaska fund managers as reasonable.[7] Lastly, ongoing reporting requirements and the screening of future investments would be required.

In conversations with our office roughly one year ago, the Alaska Permanent Fund and the state's chief investment officer expressed reservations about divestment, citing increased administrative costs and possible declines in fund performance.[8] We note, however, that divestment research we reviewed, which ultimately argues against divestment, concludes that fund performance changes are usually "negligible, and in most cases zero."[9]

Due to the nature of the global investment marketplace, it is debatable, but unlikely, that the divestment of Alaska public funds from targeted companies would have a direct, negative economic impact on those companies. Clearly, however, divestment laws have drawn considerable press attention and are a prominent factor in the ongoing debate regarding public response to the genocide occurring in Sudan.

I hope you find this information to be useful. Please do not hesitate to contact us if you have questions or need additional information.

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[6] Under the divestment models outlined in HB 5 and SB 37, fund directors would also be required to contact mutual fund managers managing *indirect* assets targeted for divestment and held by state funds. In this communication, state fund directors would be required to request consideration that such mutual fund managers divest targeted companies from their applicable portfolios, or create an alternative fund portfolio without holdings in targeted companies.

[7] Personal correspondence in January 2008 with Laura Achee, research and communications liaison, Alaska Permanent Fund Corporation, (907) 796-1522. Ms. Achee stated that most of the assets could be divested in several weeks. However, managers of two accounts that do not allow customization would have to be replaced, a process which generally requires several months. In a January 2008 conversation, Gary Bader, chief investment officer, Alaska Department of Revenue, (907) 465-4399, described a similar process, including the necessity to review contracts with seven asset account managers hired by the Alaska Retirement Management Board.

[8] Ms. Achee, research and communications liaison, Alaska Permanent Fund Corporation, expressed concern that new manager searches could yield managers that do not perform as well as current managers. Overall, in her view, divestment "would have a dampening effect on the Permanent Fund to some degree, without any guarantee that the actions would bring about the desired result in the targeted country." Gary Bader, chief investment officer, Alaska Department of Revenue, expressed his belief that Alaska funds would likely perform substantially worse after divestment.

[9] See page 6 of "Should Public Plans Engage in Social Investing?," a publication of the Center for Retirement Research at Boston College (Attachment D), for a description of empirical research on the impacts of divestment on fund performance.

LIST OF FILES

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