PHEV'09 Plug-In Hybrid and Electric Vehicles
September 28 to 30, 2009 – Montreal
Véhicules électriques et hybrides rechargeables
28 au 30 septembre, 2009 – Montréal

Islands as a Pathway

Jito Coleman

Green Toolbox

TDX Power

Electric Mobility Canada
Mobilité électrique Canada

Islands as a Pathway to What?

- Advanced Power Systems
  - Higher Renewable Penetration
  - SmartGrids
    - Smart Meters
    - Smart Controls
  - PHEVs and EV


The Smart Grid Can Deliver
Market
BENEFITS
• Enhanced energy security
• Reduced greenhouse gases
• Improved urban air quality
• Increased grid asset utilization
"Valley Filling"
(Energy for PHEVs)
PHEV

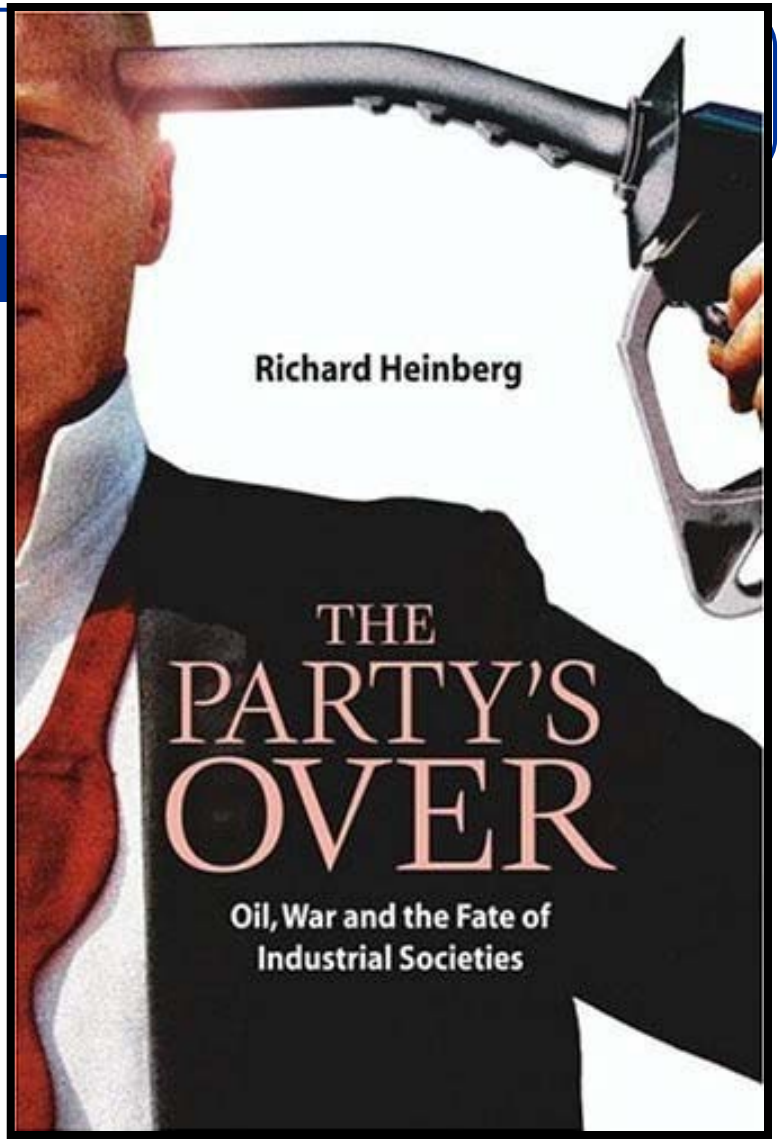
Islands as a Pathway: WHY ?

- Entirely dependent entirely expensive liquid fuels
- Smaller grid more manageble
- High impact with modest capital requirements
- Monitoring and verification is meaningful
- Public support can be easier in tight community
- Regulatory issues are less complex

Big Questions - Faster Answers

- All the Basic Questions are the SAME
  - Technical: Design, Operations, Controls, Stability
  - Economic and Financial
    - Who is rewarded?
    - Who pays and how much?
  - Social: How do people feel?
  - Regulatory: What needs to change?
- It's affordable, faster and provides insights and maybe some answers.

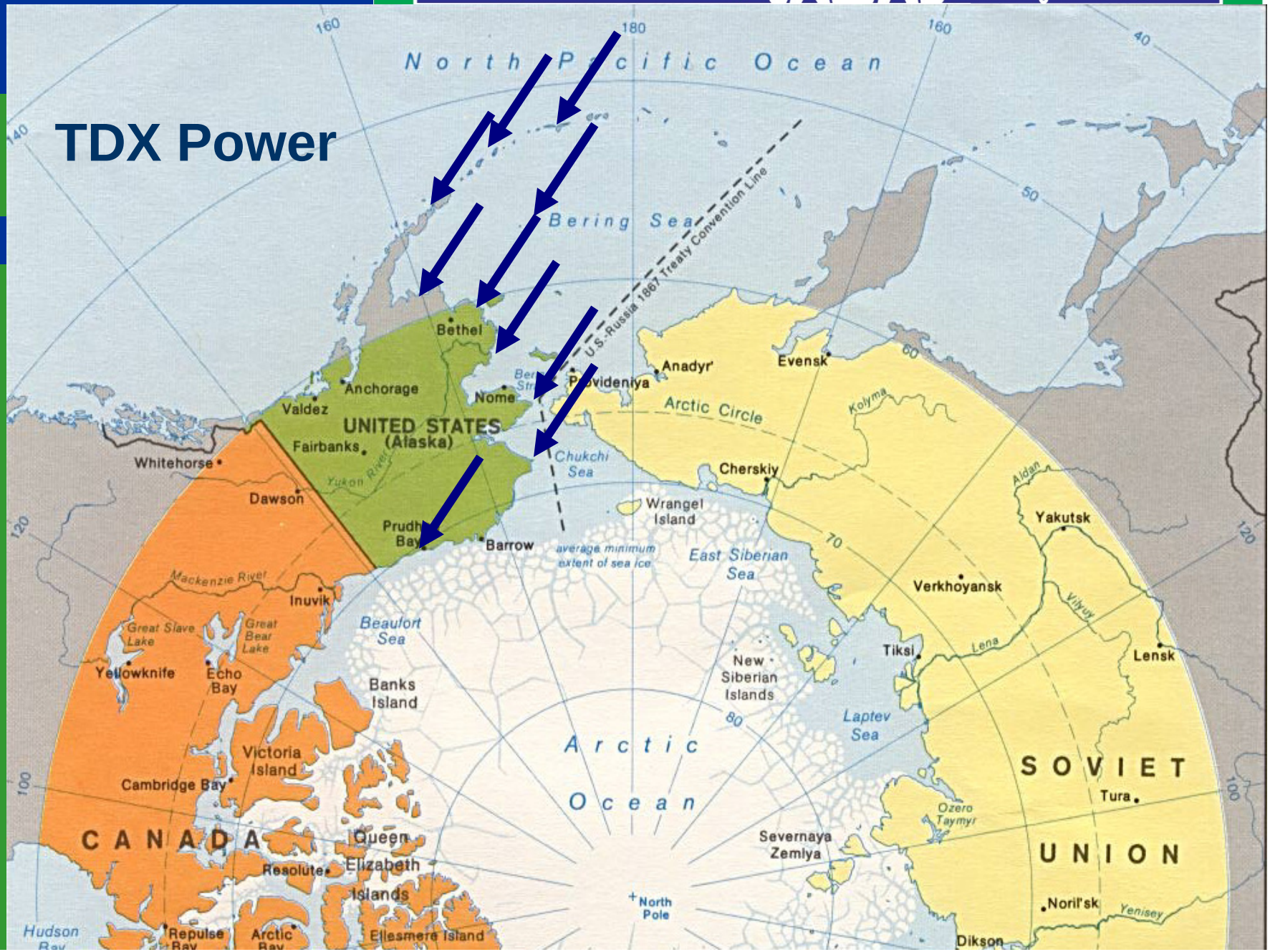
So What's Happening?



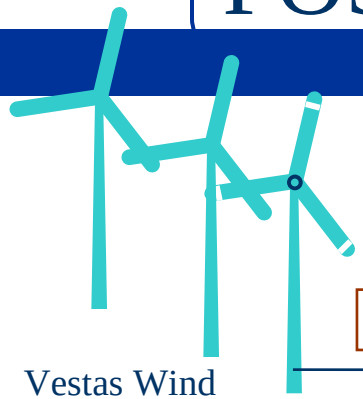
So What's Important

1. Conservation
2. Smartening UP
3. Renewables
4. EV and PHEV

TDX Power


North Pacific Ocean
Bering Sea
U.S.-Russia 1867 Treaty Convention Line
Bethel
Anchorage
Valdez
Nome
UNITED STATES
(Alaska)
Fairbanks
Whitehorse
Yukon River
Dawson
Prudhoe Bay
Barrow
Chukchi Sea
Anadyr'
Provideniya
Evensk
Arctic Circle
Kolyma
Cherskiy
Wrangel Island
average minimum extent of sea ice
East Siberian Sea
Aldan
Yakutsk
Verkhoyansk
Vilyuy
Lena
Lensk
Tiksi
New Siberian Islands
Laptev Sea
Mackenzie River
Inuvik
Great Slave Lake
Great Bear Lake
Yellowknife
Echo Bay
Beaufort Sea
Banks Island
Victoria Island
Cambridge Bay
Arctic Ocean
CANADA
Queen Elizabeth Islands
Resolute
North Pole
Severnaya Zemlya
Ozero Taymyr
SOVIET UNION
Tura
Noril'sk
Yenisey
Dikson
Hudson Bay
Repulse Bay
Arctic Bay
Ellesmere Island

POSS Camp Power System Diagram



Vestas Wind Turbines

Diesel Gensets

encorp GPC

PLC

encorp GPC

encorp GPC

Synchronous Condenser

IREQ Frequency Regulator

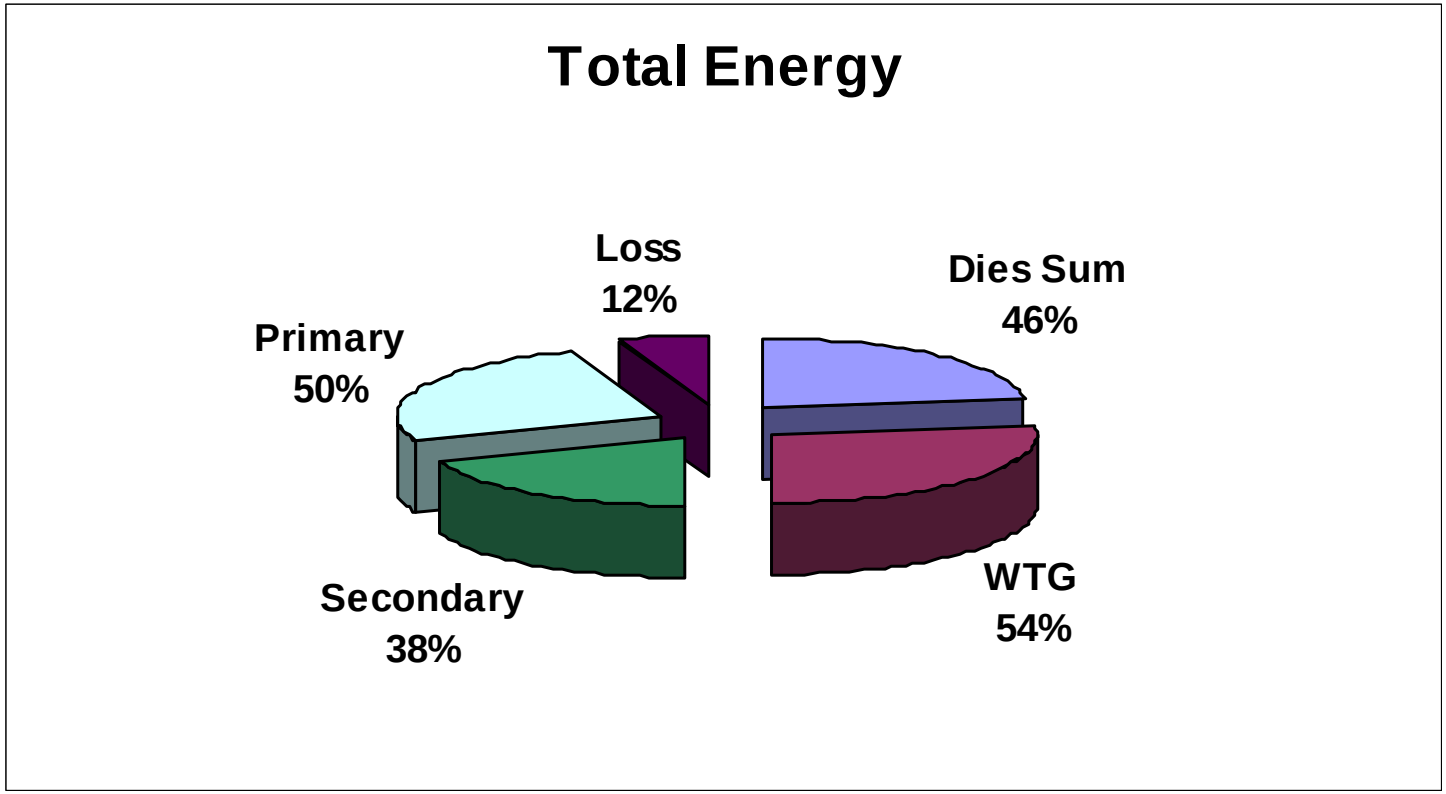
Supervisory PLC

Modem

Secondary Load Thermal Tank

TDX Load

Performance Summary with 1 Turbine



Next Vision

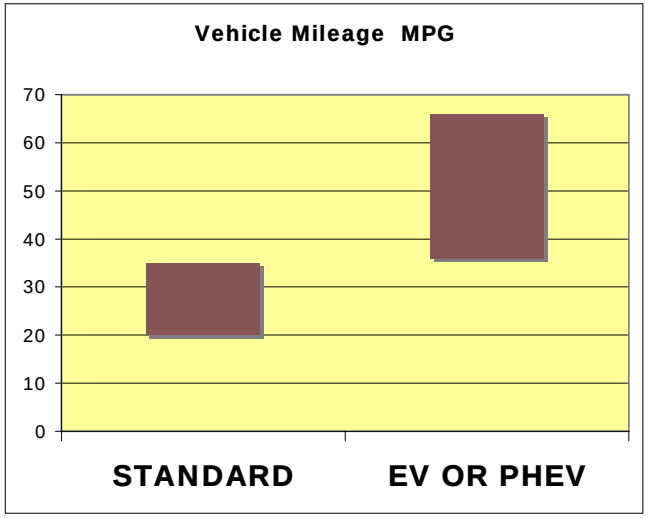
- Increase Renewable even more
- Serve ALL power needs
  - Electricity
  - Thermal
  - Transportation (4 wheeler, trucks, vans)
- Create Test Bed
- Find the Synergies
- Define the Value Propositions

EV 101

Fuel Economy (Light Duty Fleet Average)
- 3.5 miles / kWh

Diesel to Electricity Conversion
- 14 kwhr / gallon

So EV gets 50 mpg from Diesel fueled power plant



Now let's add Renewables !!

ATV Options

Mfgr	Vehicle	Type	Wheels Drive	Miles Range	Lbs Weight	Type Battery	Volts
				miles	lbs		
Doran	e-ATV	ATV	2	35	540	Flooded	36
EVS	e.Force	ATV	Rear	20	624	NiMH	72
Zap	Dude	ATV	Rear	25	707	AGM	48
Barefoot	EUV	ATV	2 or 4	40	820	Lithium	80
Ruff& Tuff	RTEV	UTV	2	30	1330	AGM	48
X-Treme	XU-3000	UTV	2	35	1360	AGM	48
GEM	eL XD	NEV	2	40	1550	AGM	72
Bad Boy	Buggy	UTV	4	25	1600	AGM	48
Polaris	Ranger	UTV	4	50	1700	Flooded	48


TDX POWER
PRIVATE PROPERTY
NO TRESPASSING
VIOLATORS WILL BE PROSECUTED

Value Propositions for EVs

Short Term: Seconds *Regulation*

Medium Term: Minutes *Spinning Reserve*

Long Term: Hours *Load Shifting*

Value Propositions

Short Term: Seconds (*Regulation)*

- Line Transients: voltage, harmonics
- Switching Disturbances
- Power Electronics Value: Huge
- Electrical Storage Value: Important

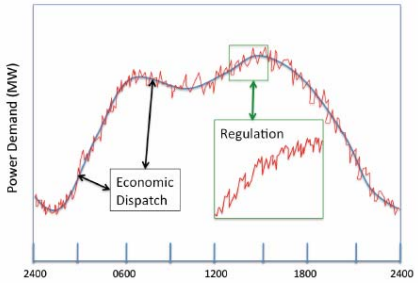
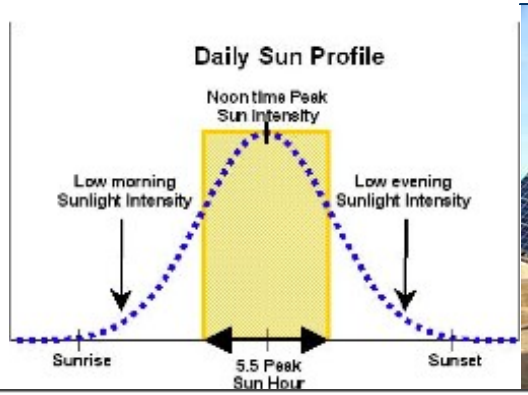


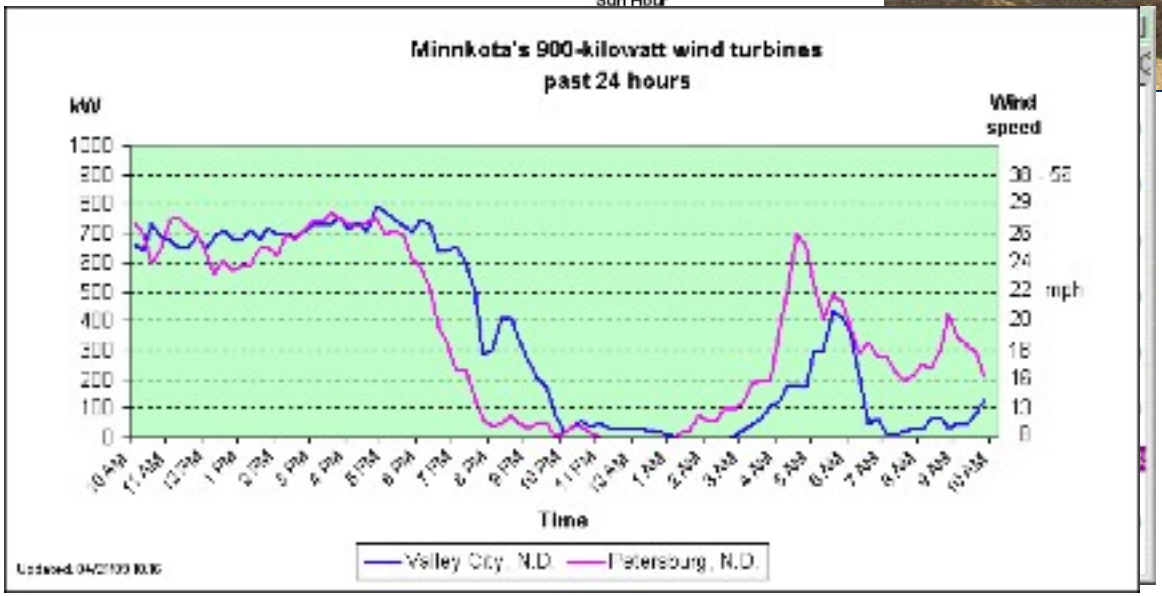
Figure 2: The inter-hour adjustments of regulation contrasted with the economic dispatch of peak power. Regulation takes place during all hours of the day, not just during times of peak demand. Only three hours of the afternoon are magnified here, but regulation is needed throughout the day.

Medium Term: Minutes (*Spinning Reserve - Ramping*)

- Renewable Add New Variations
- System Response Limited by Equipment Ramp Rates
- Electrical Storage Value: Huge

Wind and Solar are Dynamic





EMC MEC Electric Mobility Canada Mobilité électrique Canada

Quantified Value Proposition

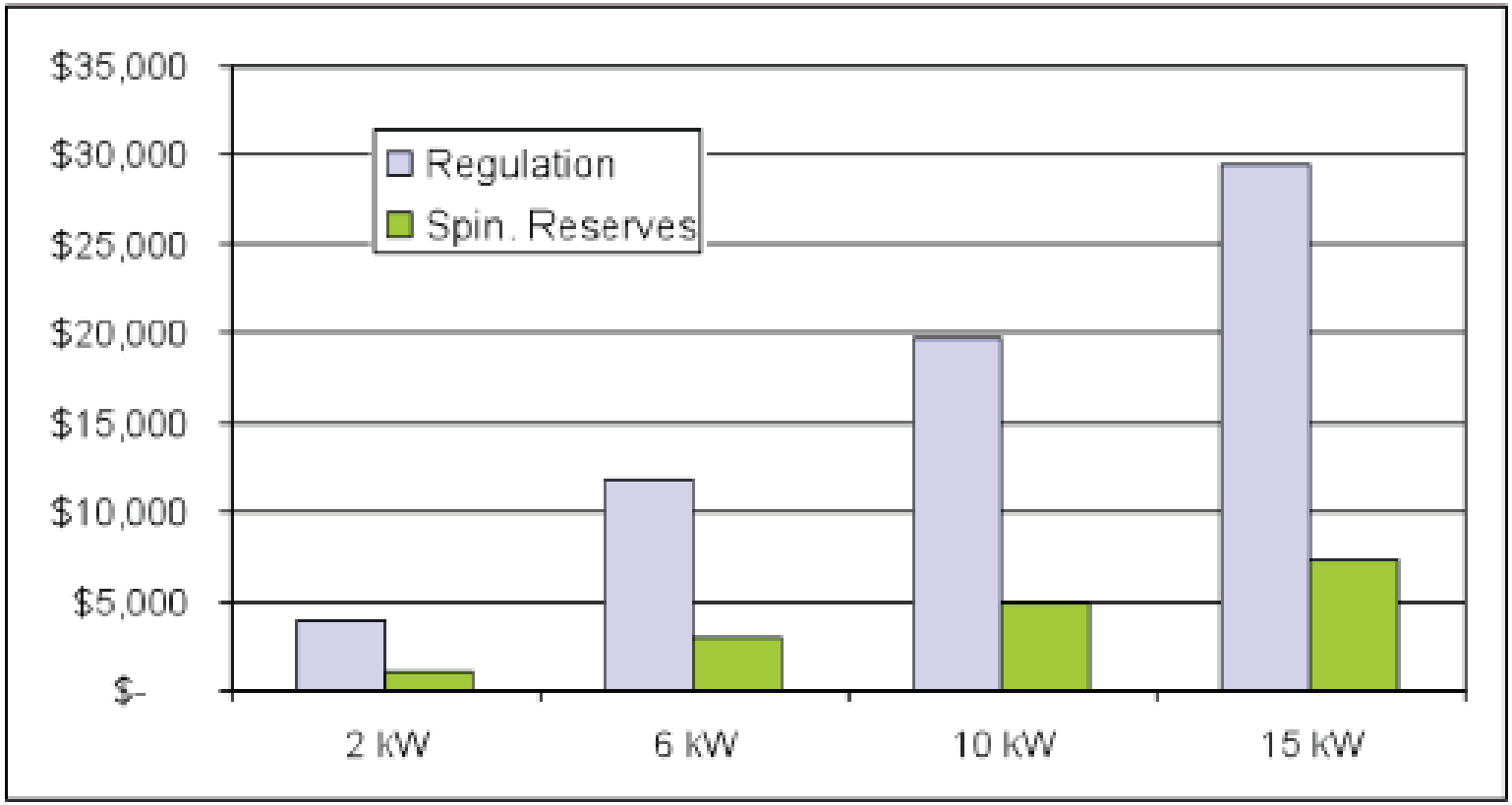
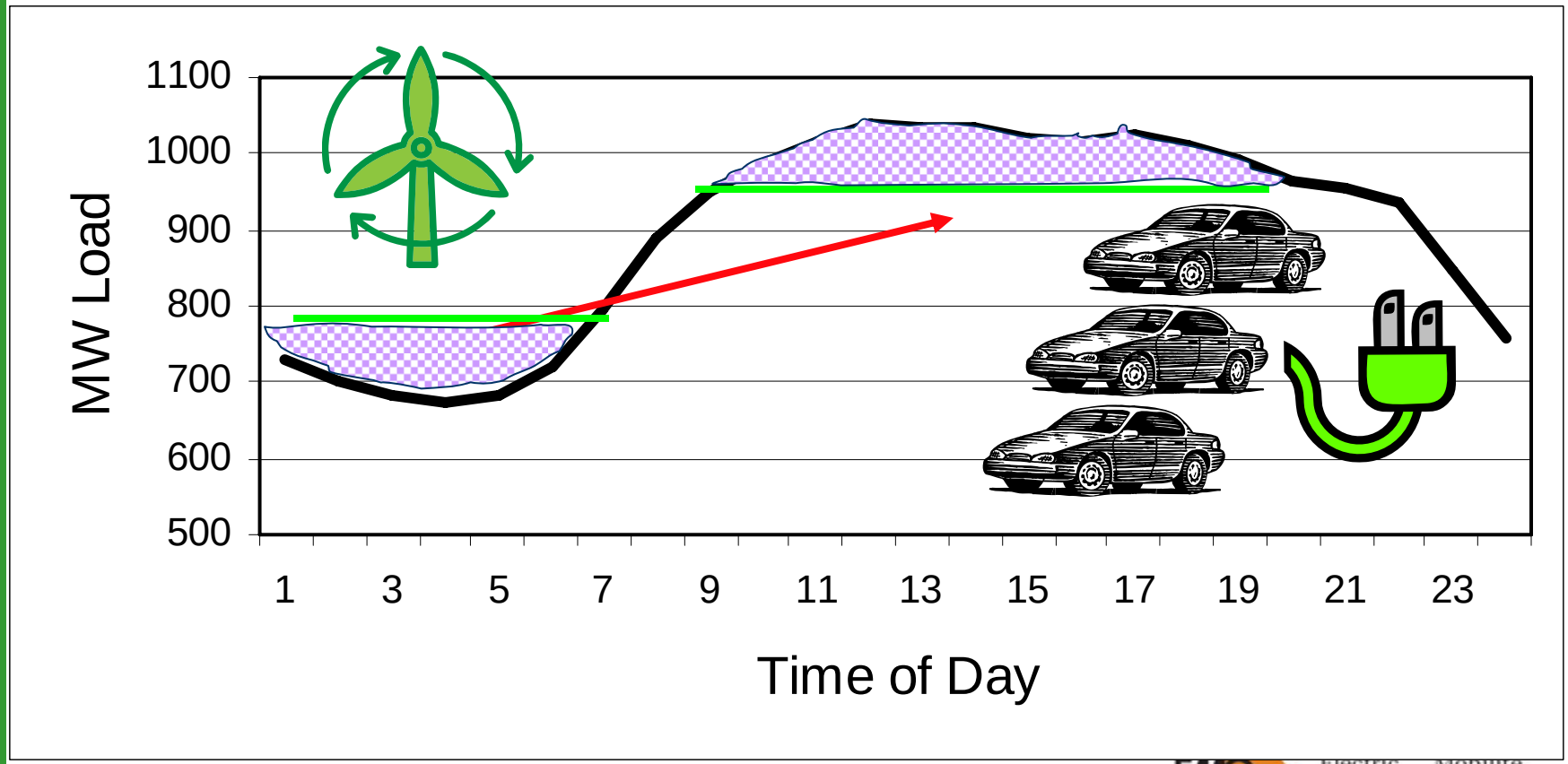


Figure 4: Discounted present value of gross revenues generated from selling regulation and spinning reserve, at varying power levels.

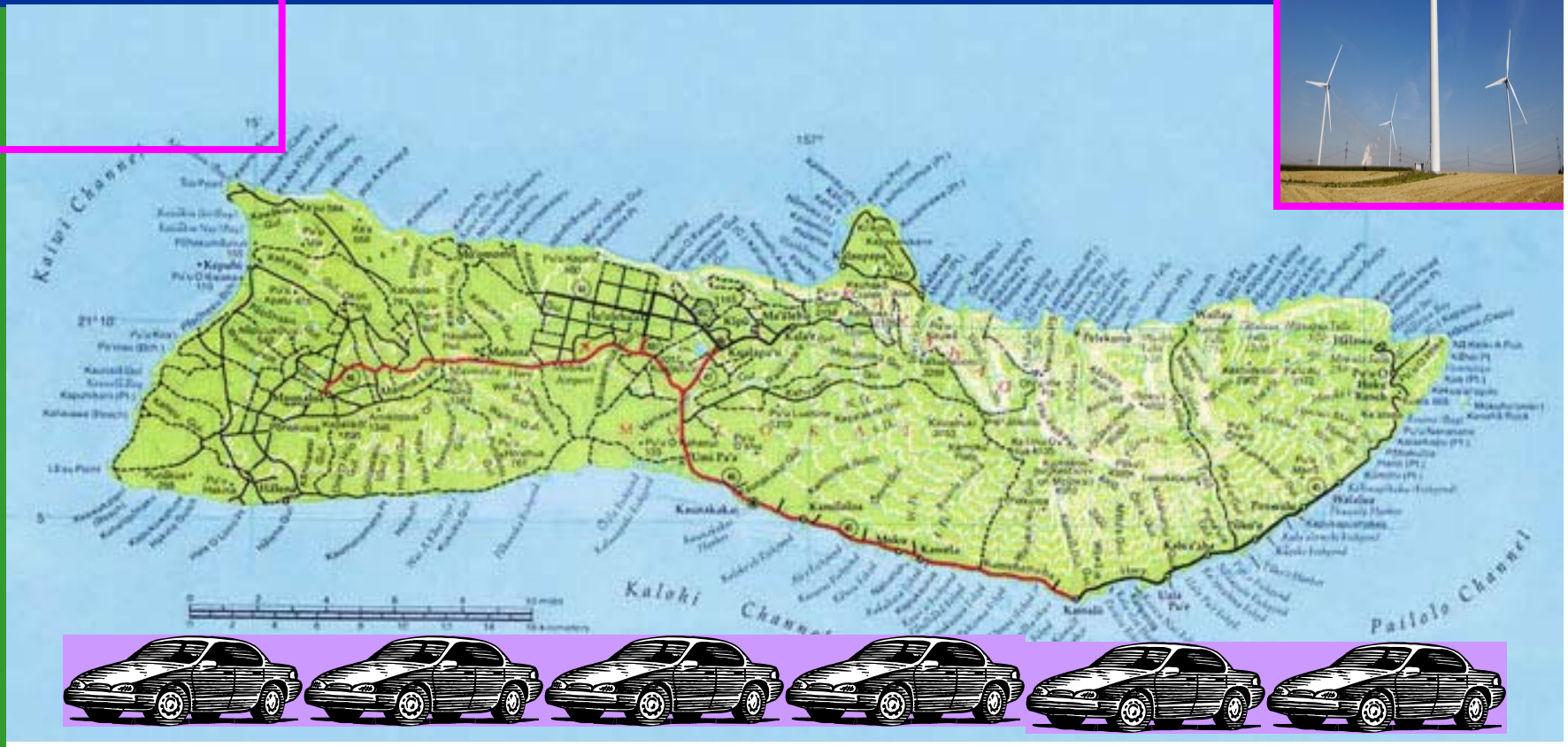
Klempton et al U of Delaware

Load Shifting

"PHEVs are the perfect dance partner to wind energy" with smart charging. EPRI



Islands as a Pathway



SAMPLE ISLAND:

MOLOKAI

POPULATION: 6000 people/2500 residences
VEHICLES: 3000 vehicles = 6,000 gal/day
ELECTRIC LOAD: (5 MW peak / 2 MW low)
105 MWhr/day = 9,700 gal/day

Convert 1500 vehicles to electric vehicles —

1500 vehicles @ 40 miles/day @ 3 miles/kwhr =
20 MWhr/day increase in electrical load

ADJUSTED ELECTRICAL LOAD:
125 MWhr/day = 11,550 gal/day

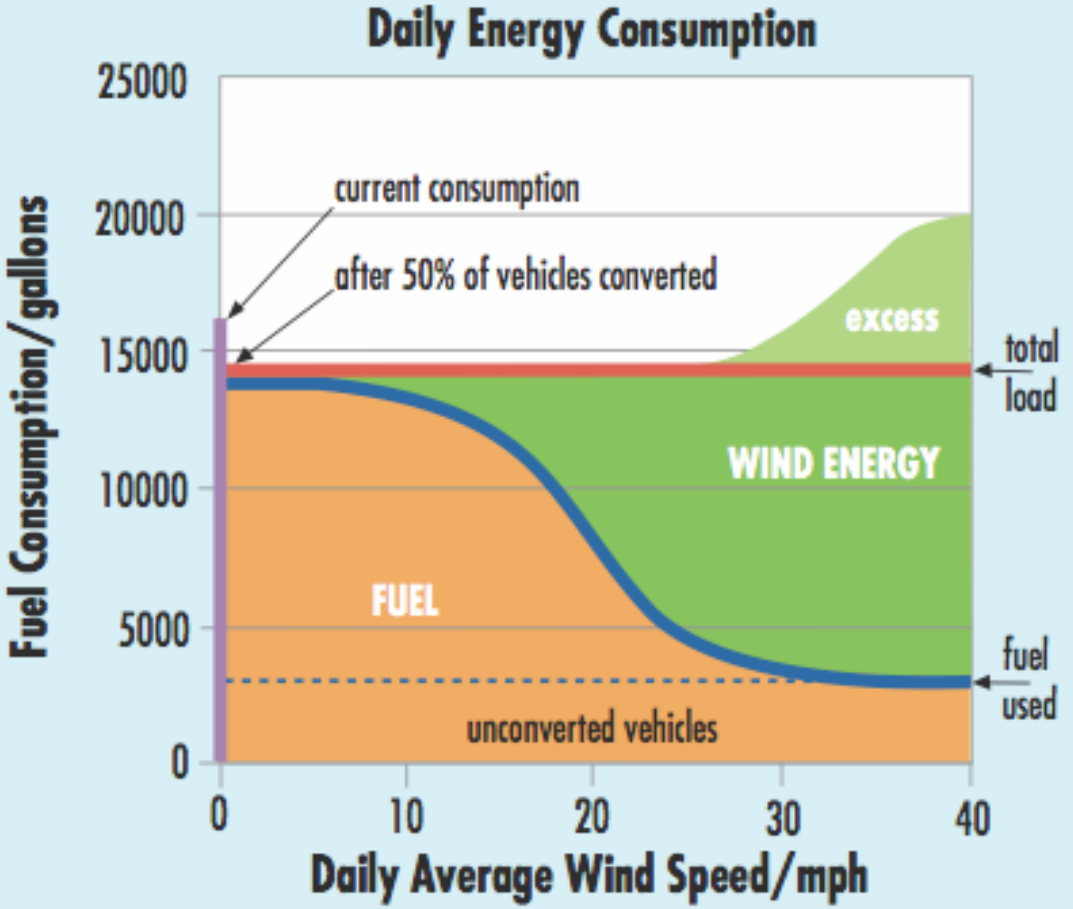
V2G Grid Stability Function —
with 80% vehicles connected

- 3MW rotating reserve (60% peak load)
- 20 MWhrs of storage (50% SOC utilization)

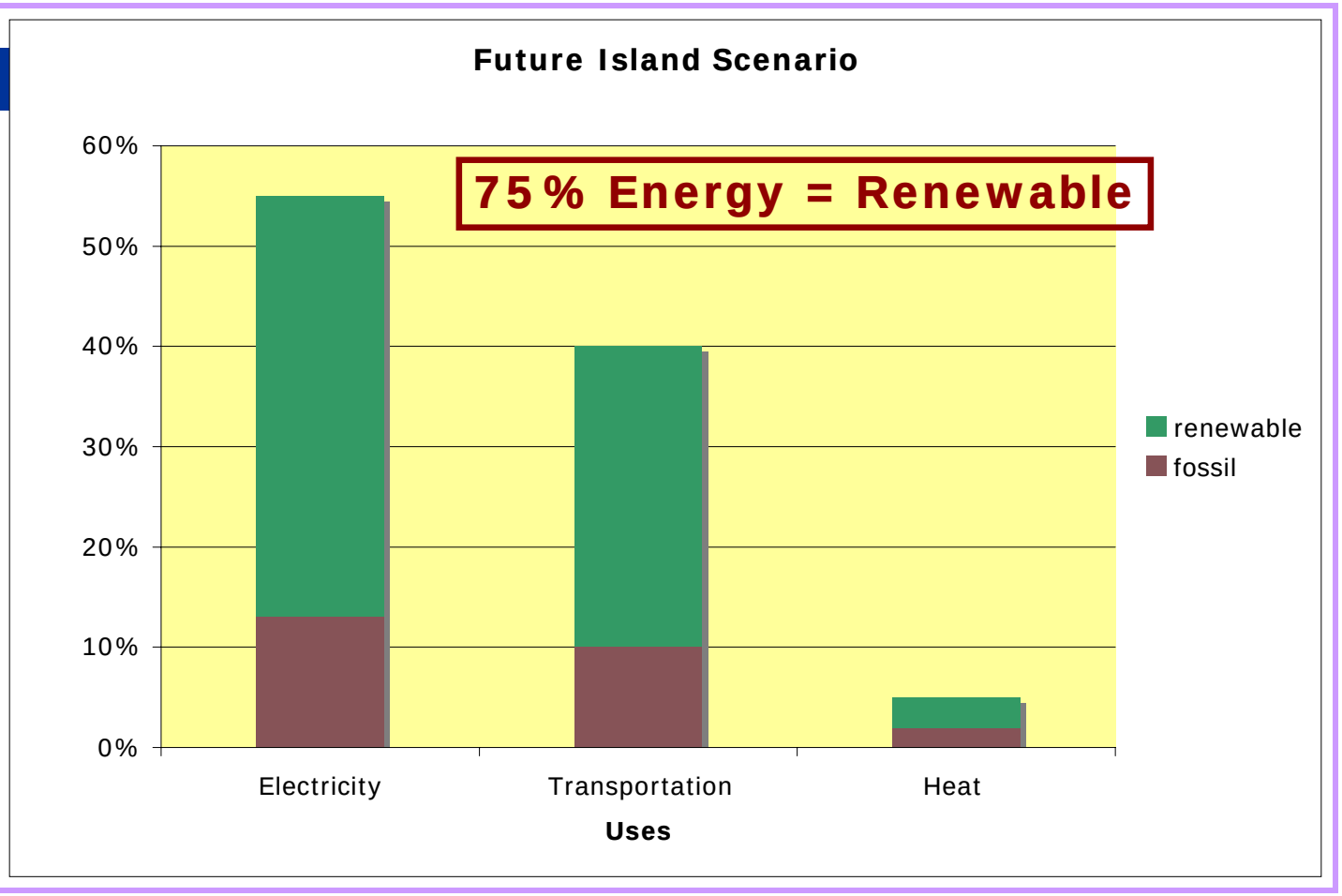
Add 8 MW of wind turbines —

DAILY IMPACT:

WIND SPEED MPH	WIND ENERGY MWh	FUEL SAVED gallons
0	0	1200
12	16	1472
16	38	3500
24	115	10,580
32	176	11,500



Molokai Renewable Future ???



We are getting Smarter

- Synergies Are There
- Show Me with Hardware
- Go Big or Go Home