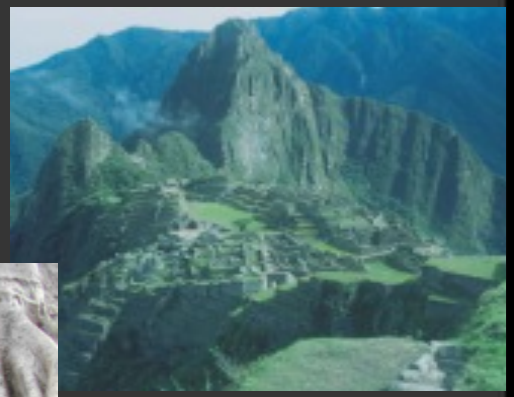
Local Energy History & The Foundation for our Energy Future

Renewable Energy in the Mad River Valley

MaclayArchitects
CHOICES IN SUSTAINABILITY

Net-Zero Worlds








MaclayArchitects
CHOICES IN SUSTAINABILITY

Evolution & Worlds

MaclayArchitects
CHOICES IN SUSTAINABILITY

Settlement / Organisms / Ecosystems

"We shape our buildings, and afterwards our buildings shape us."

Winston Churchill

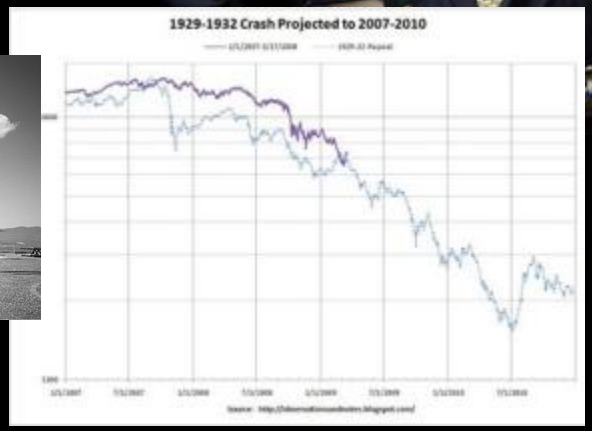
MaclayArchitects
CHOICES IN SUSTAINABILITY

The Non Net-Zero Tradition

MaclayArchitects
CHOICES IN SUSTAINABILITY

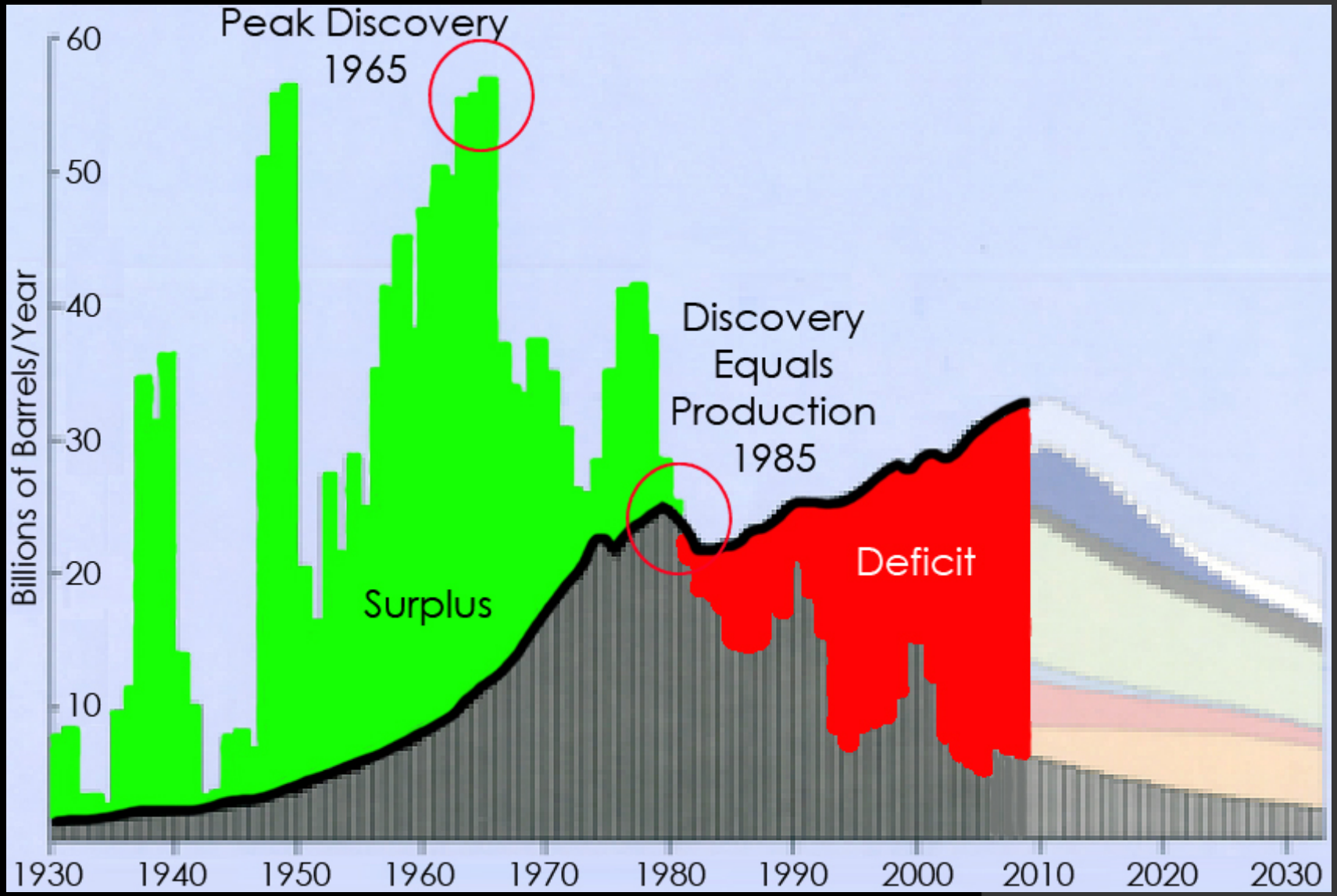
Global Challenges & Our Buildings & Community's Impacts

economy, energy, environment, equity & population

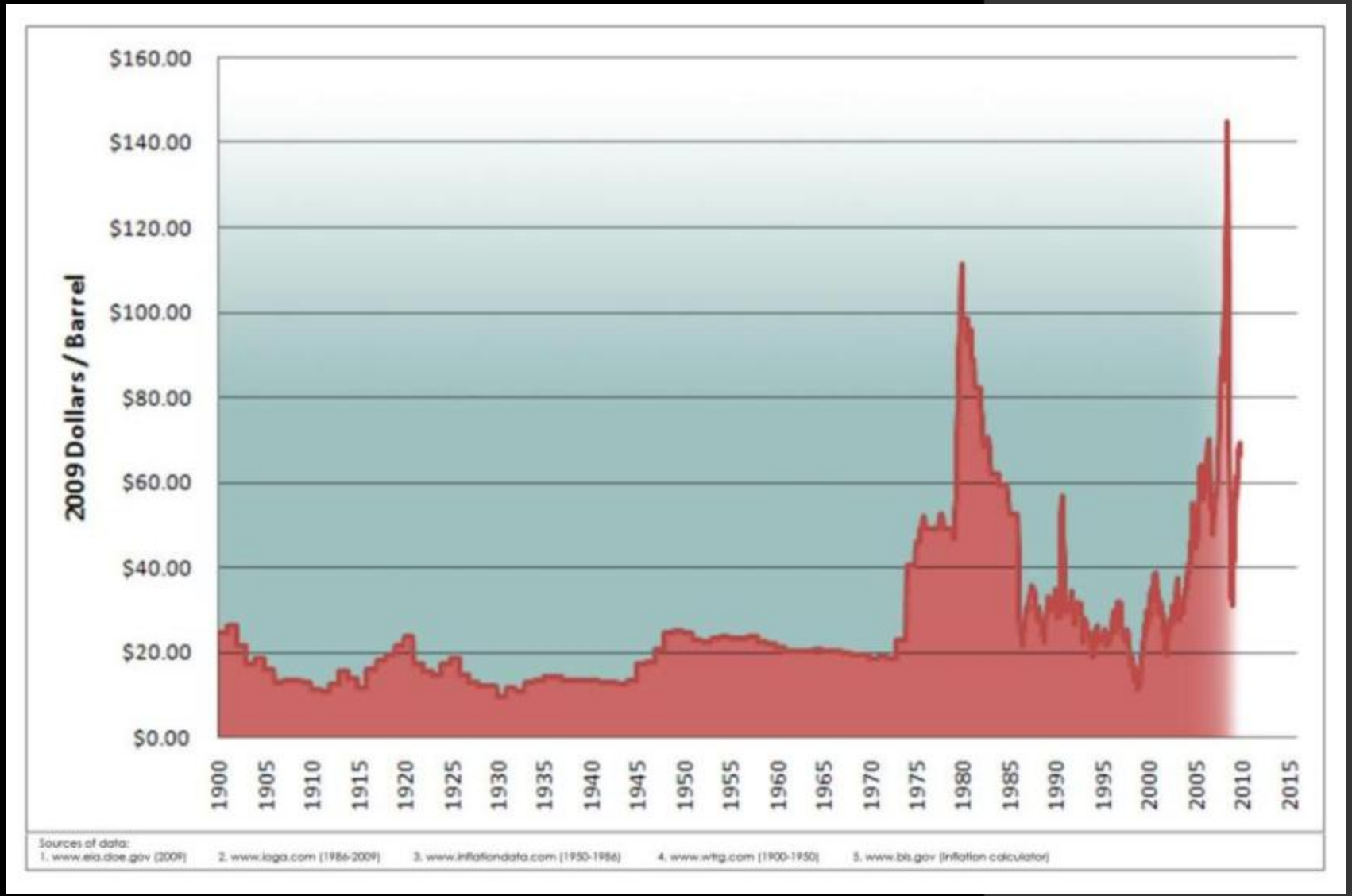


MaclayArchitects
CHOICES IN SUSTAINABILITY

Peak Oil

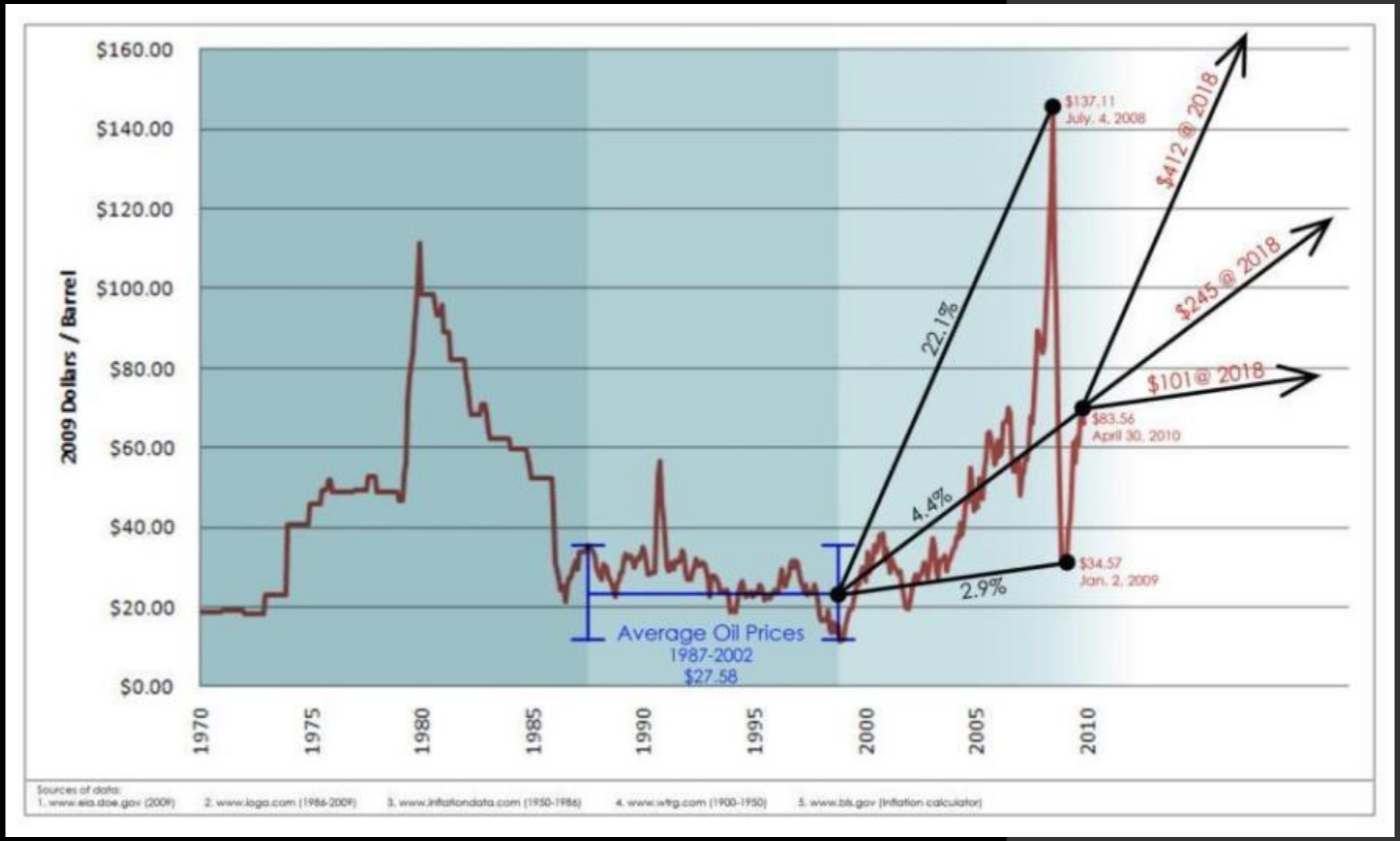


Historical World Oil Price



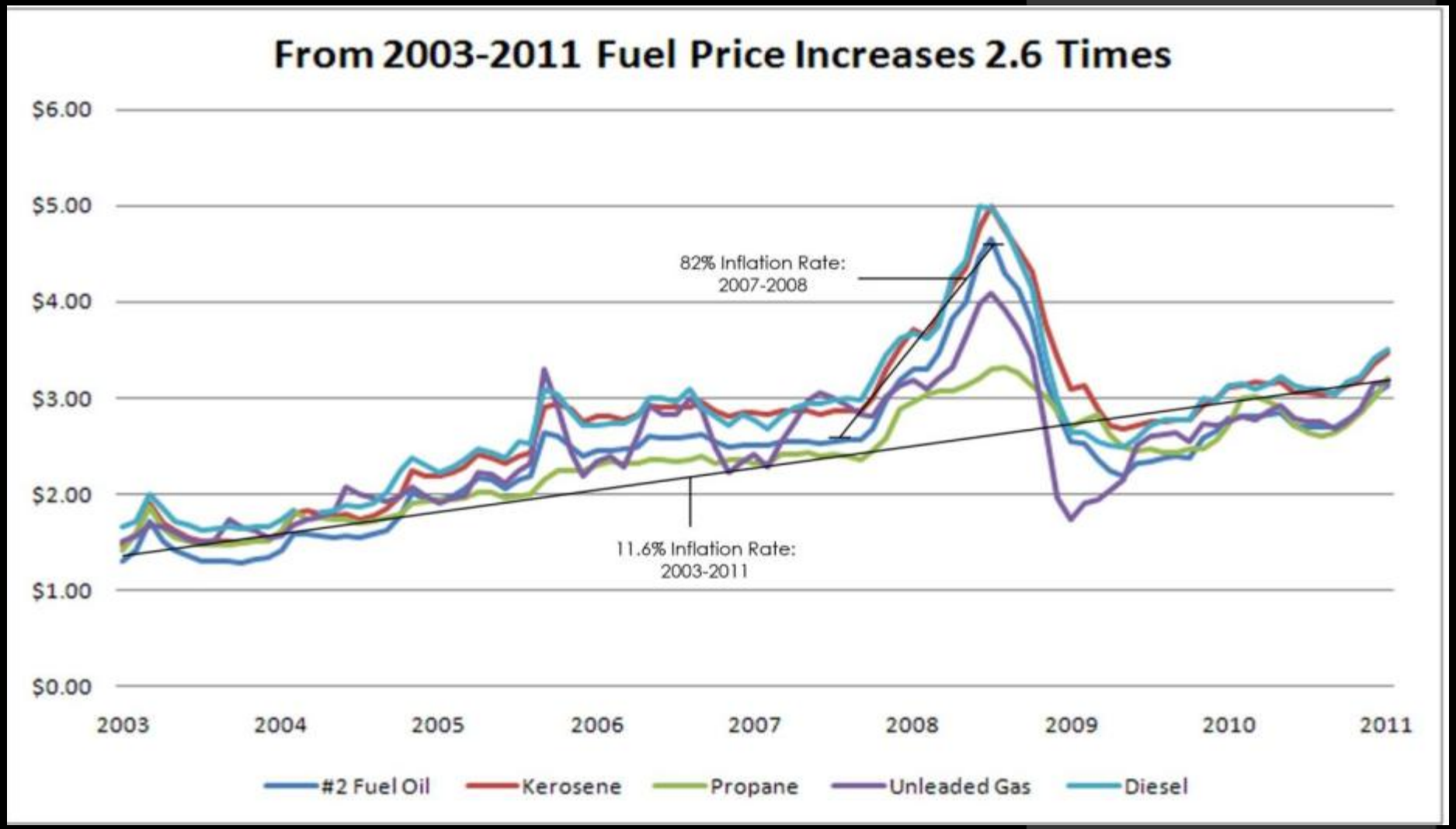
MaclayArchitects
CHOICES IN SUSTAINABILITY

Projected Oil Price Based on Historical Growth



MaclayArchitects
CHOICES IN SUSTAINABILITY

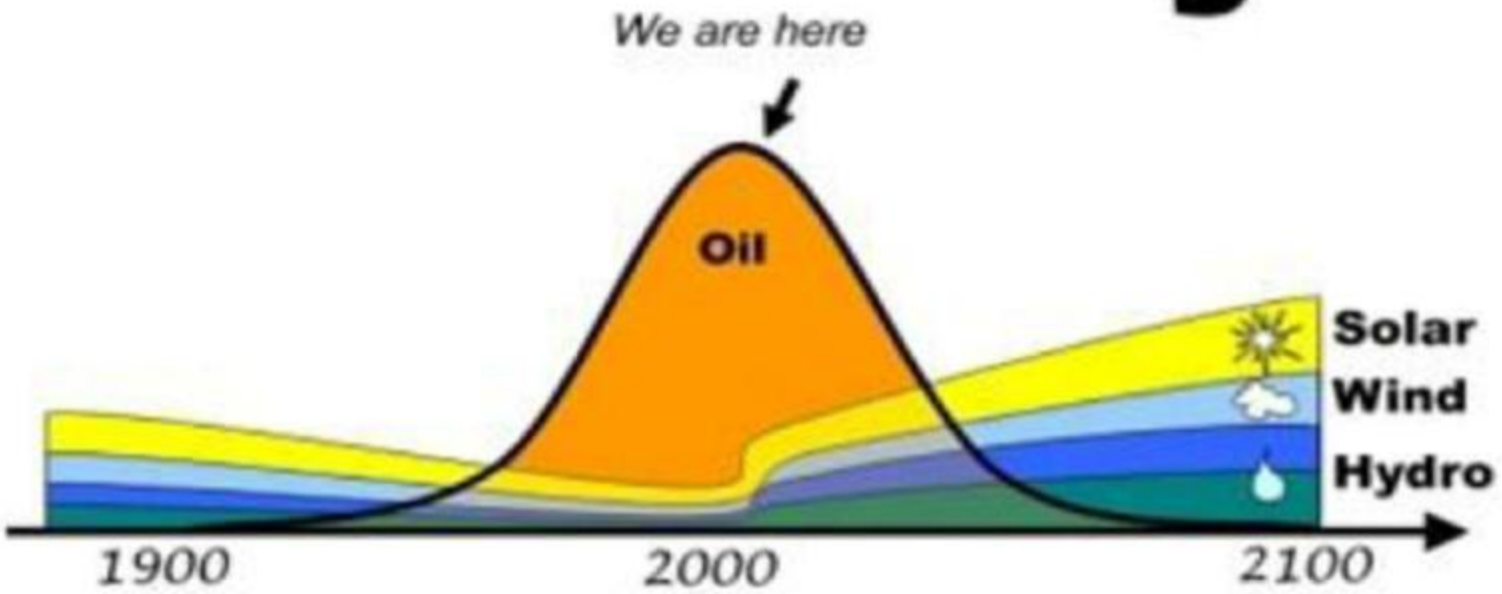
Vermont Historical Fuel Price



Inflation Rates Calculated for #2 Fuel Oil
Fuel Price Data from VT Fuel Price Report, VT Department of Public Service

MaclayArchitects
CHOICES IN SUSTAINABILITY

Get ready



for a renewable world

EarthTurbines

NRG

MaclayArchitects
CHOICES IN SUSTAINABILITY

The Evolution of Energy and Settlement Patterns

Farming/Agriculture

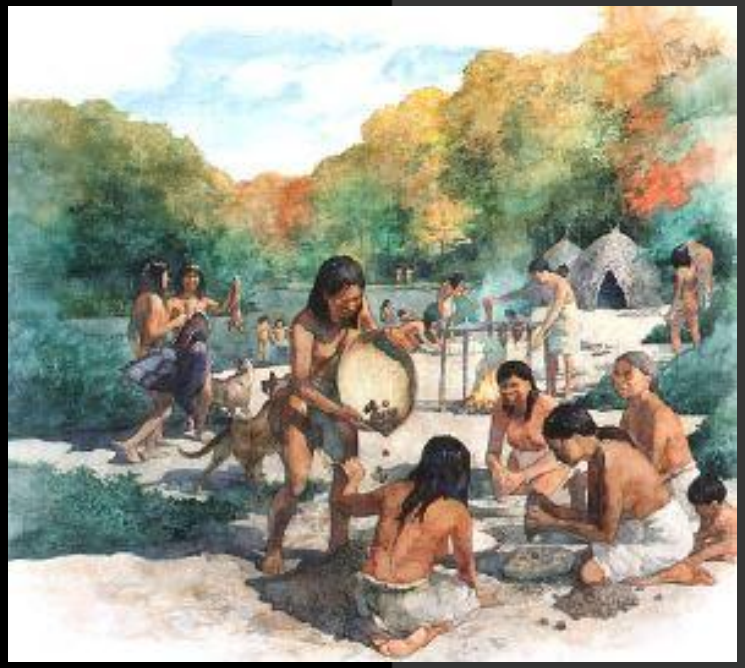
Coal

Oil

MaclayArchitects
CHOICES IN SUSTAINABILITY

Hunters / Gatherers

The Evolution of Energy and Settlement Patterns



MaclayArchitects
CHOICES IN SUSTAINABILITY

Agricultural Villages

The Evolution of Energy and Settlement Patterns






MaclayArchitects
CHOICES IN SUSTAINABILITY

Mills & Small Towns

The Evolution of Energy and Settlement Patterns

MaclayArchitects
CHOICES IN SUSTAINABILITY

Small Cities & Trade

The Evolution of Energy and Settlement Patterns

MaclayArchitects
CHOICES IN SUSTAINABILITY

Large Cities & Coal

The Evolution of Energy and Settlement Patterns

MaclayArchitects
CHOICES IN SUSTAINABILITY

Suburbs & Oil

The Evolution of Energy and Settlement Patterns

MaclayArchitects
CHOICES IN SUSTAINABILITY

Evolution & Worlds in Vermont

MaclayArchitects
CHOICES IN SUSTAINABILITY

Mad River Watershed

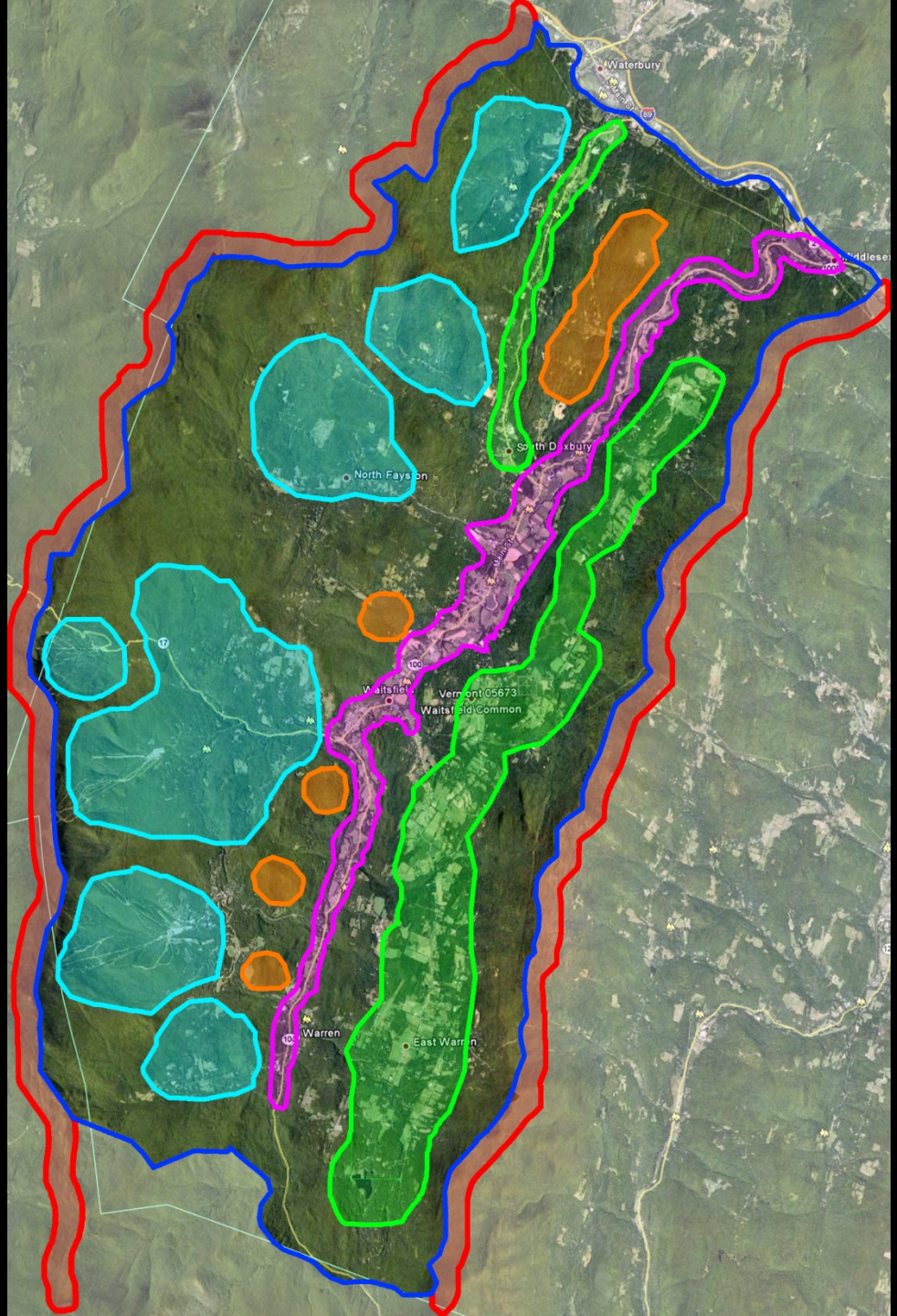
Mad River Watershed

Outside Watershed

Watershed Boundary

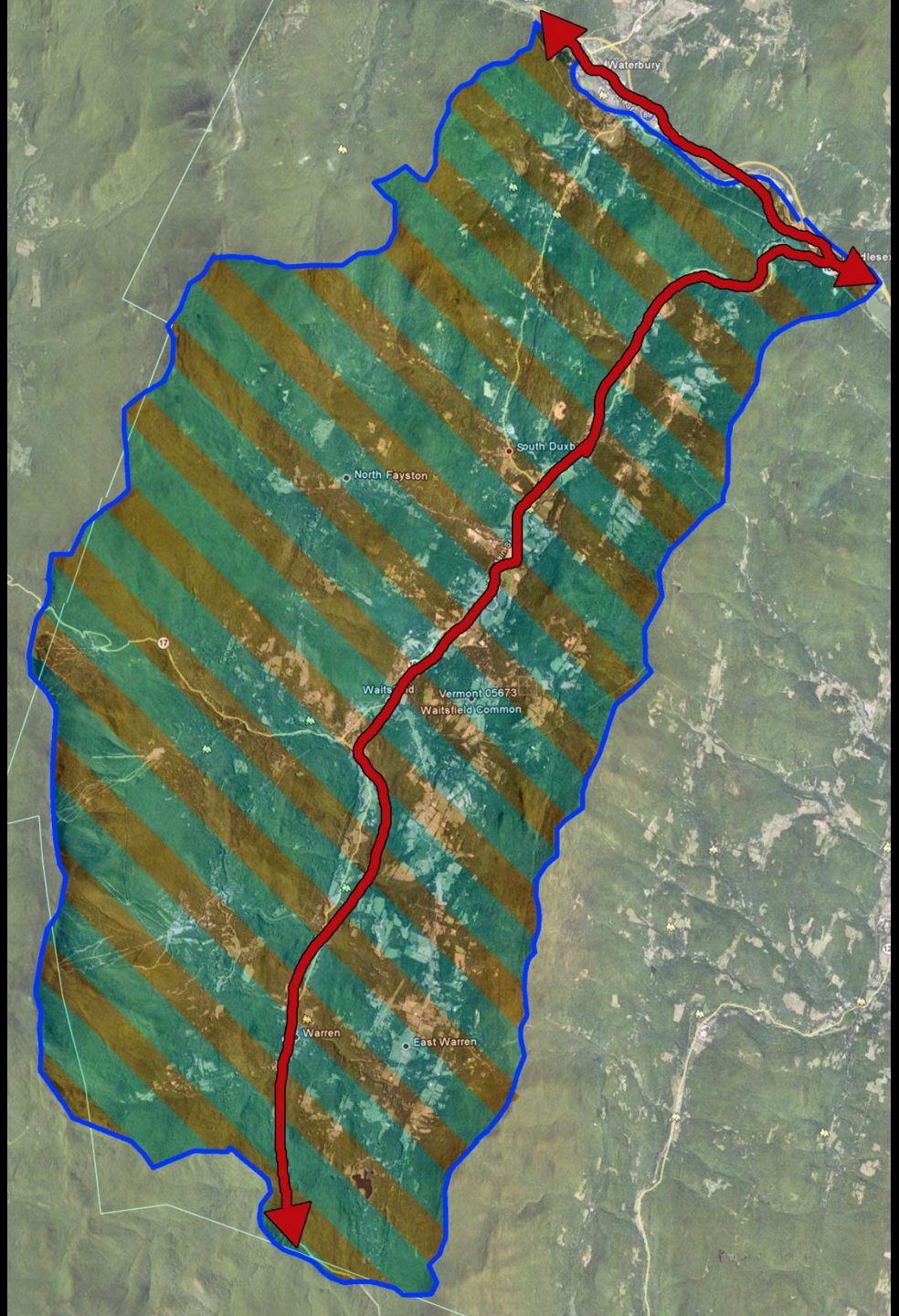
MaclayArchitects
CHOICES IN SUSTAINABILITY

Mad River Valley
Morphology / Ecosystems



- Steep Slopes
- Hilltops/Knolls
- Bowls
- Valley Floor
- Plateau
- Ridge
- Watershed Boundary

MaclayArchitects
CHOICES IN SUSTAINABILITY



Land Use: Hunter / Gatherer

Pre 1750s

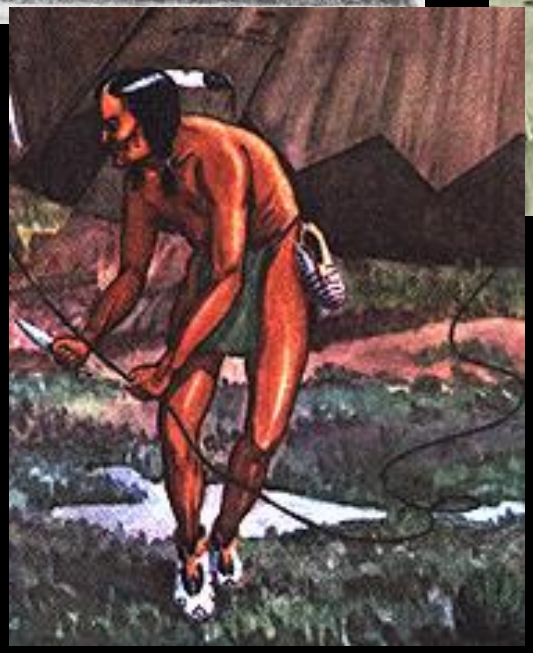
Agriculture / Hunting

Forest Conservation

Transportation - River Paths

MaclayArchitects
CHOICES IN SUSTAINABILITY

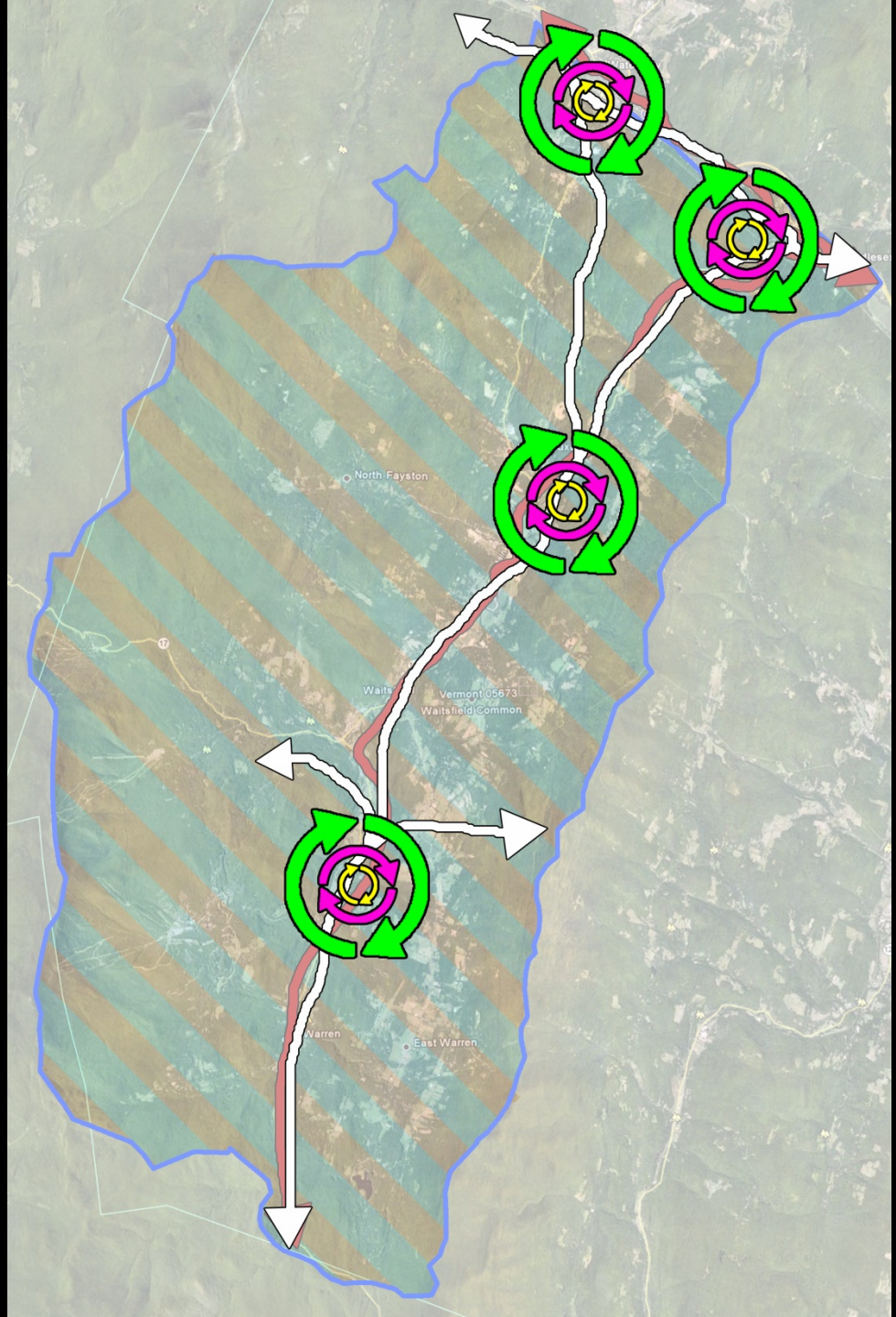
Land Use and Life in the Hunter / Gatherer Era



MaclayArchitects
CHOICES IN SUSTAINABILITY

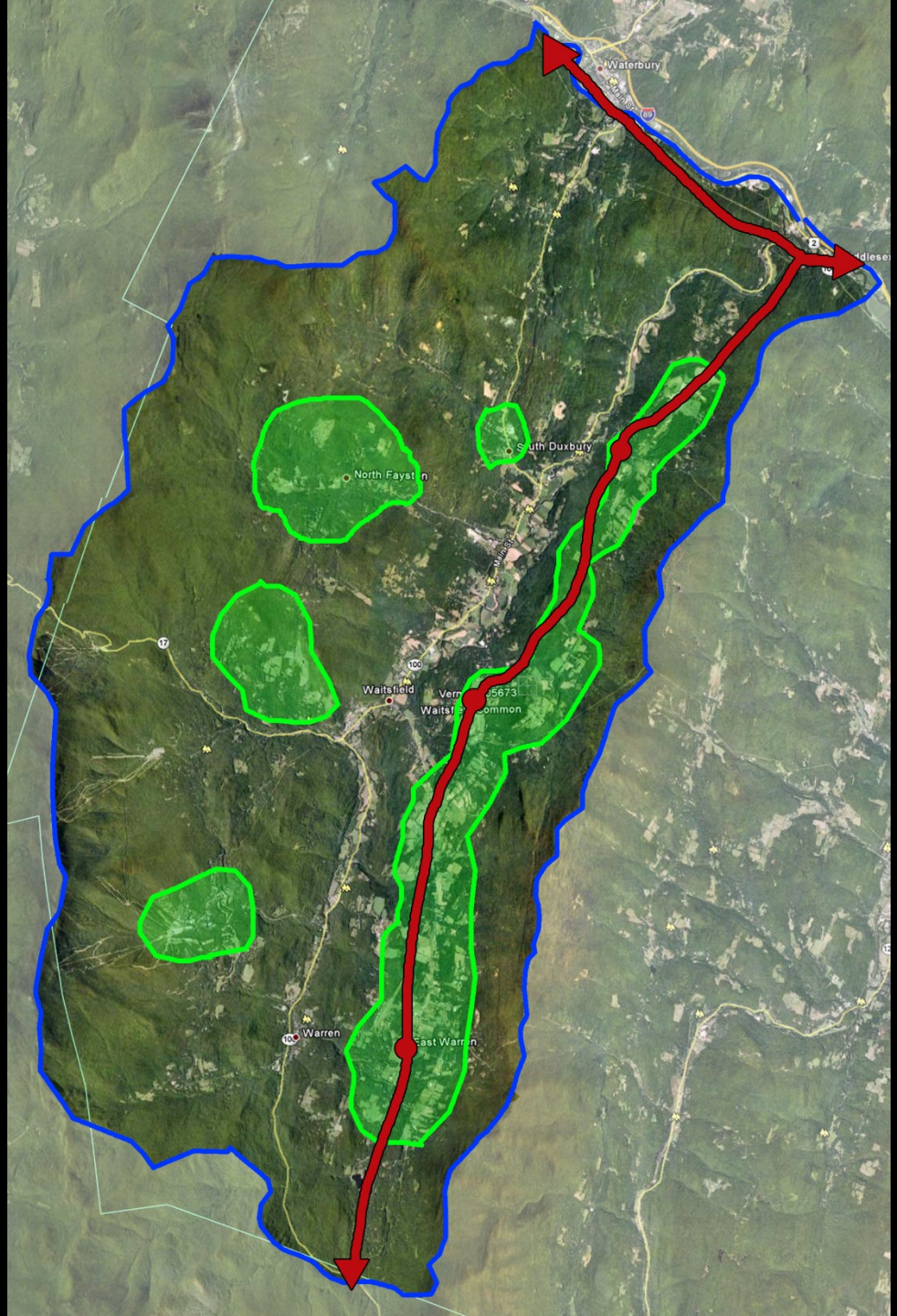
Flow: Hunter / Gatherer

Pre 1750s



IN		OUT
	Energy	
	Food	
	Products	
→	Population	→

MaclayArchitects
CHOICES IN SUSTAINABILITY



Land Use: Subsistence Farming

c. 1800-1850

Agriculture

Forest/Conservation

Transportation

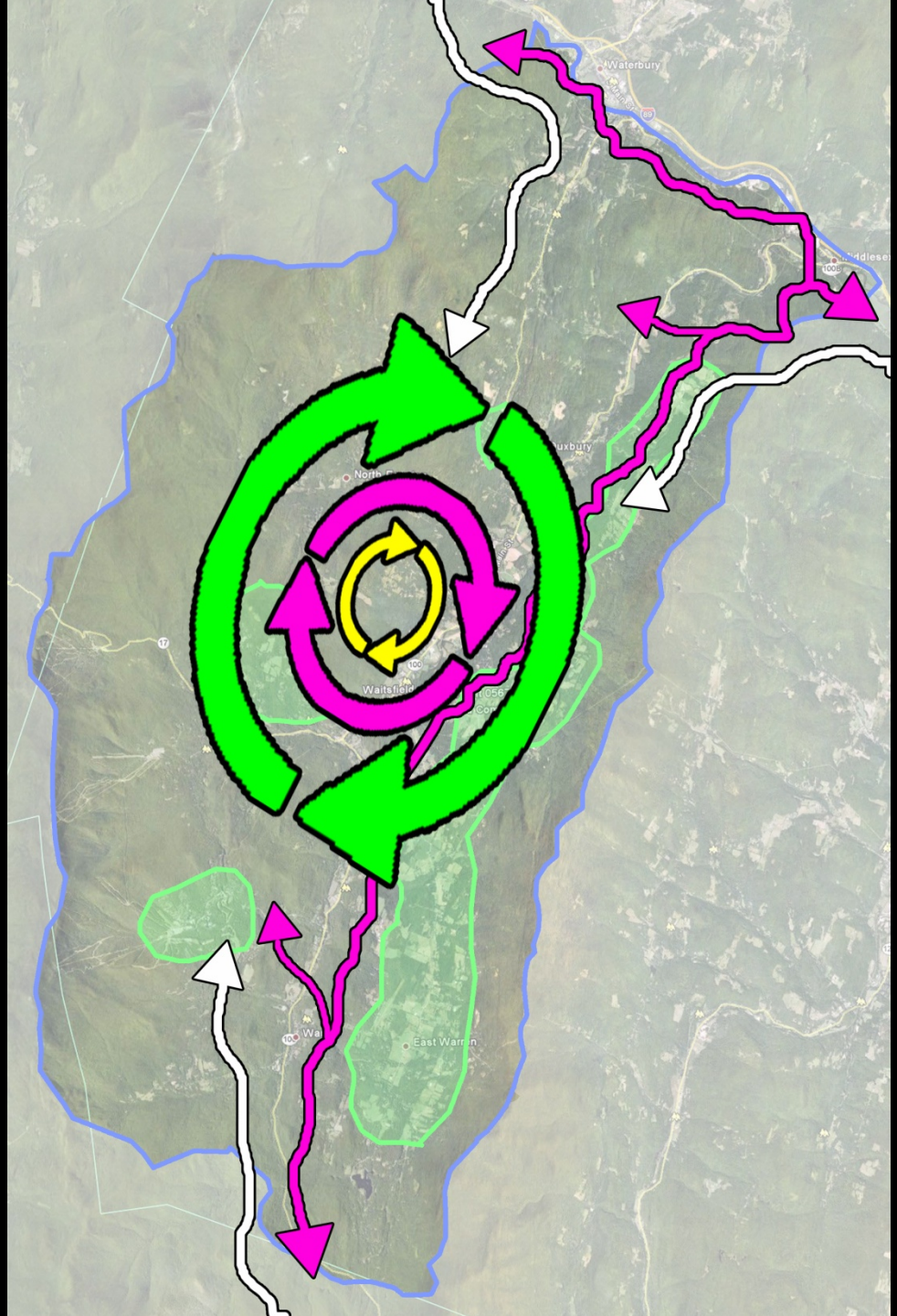
MaclayArchitects
CHOICES IN SUSTAINABILITY

Energy in the Subsistence Farming Era

MaclayArchitects
CHOICES IN SUSTAINABILITY

Life in the Subsistence Farming Era

MaclayArchitects
CHOICES IN SUSTAINABILITY

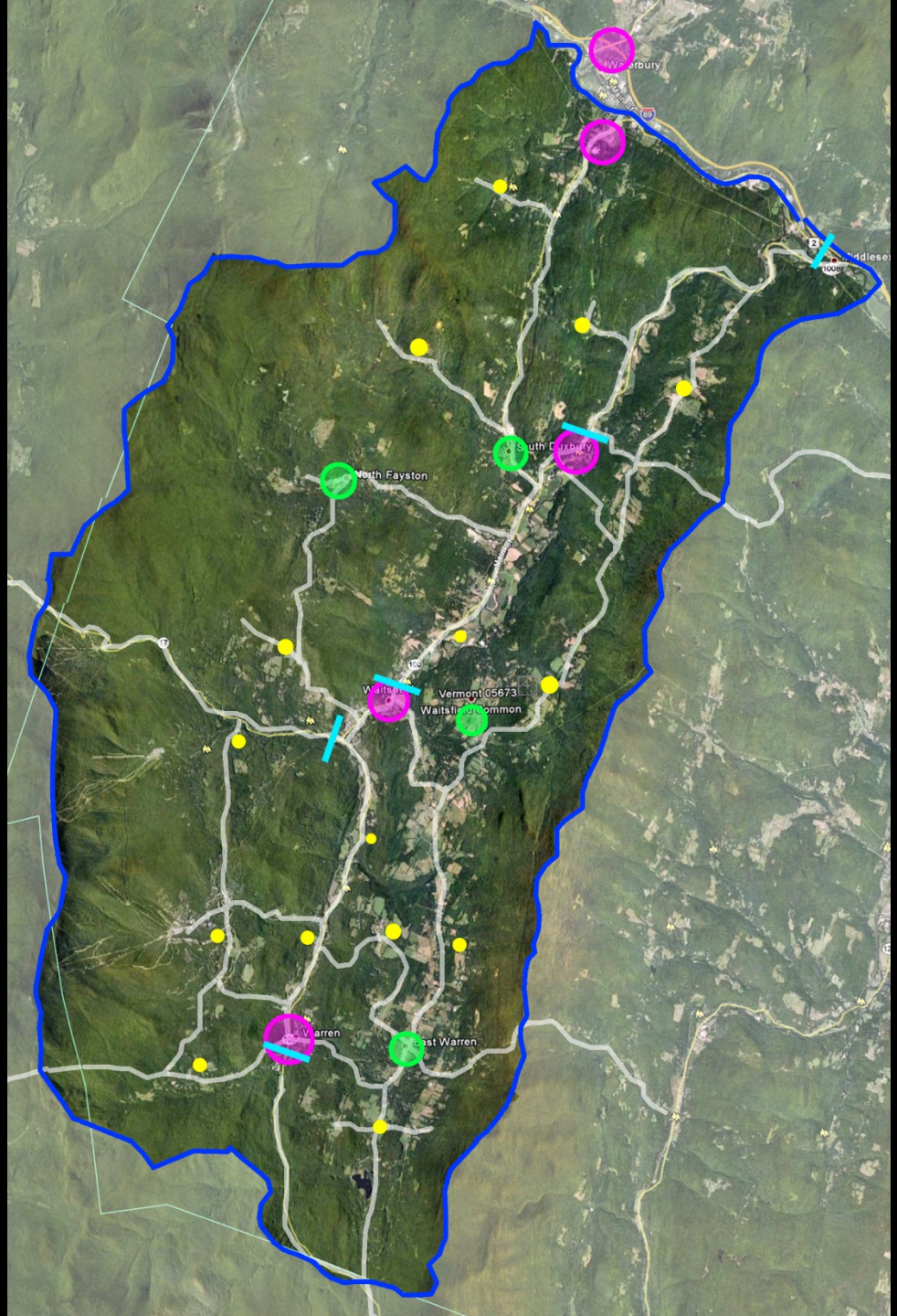


Flow: Subsistence Farming

c. 1800-1850

IN		OUT
	Energy	
	Food	
→	Products	→
⇨	Population	⇨

MaclayArchitects
CHOICES IN SUSTAINABILITY



Land Use: Milltowns

c 1850-1900

- Milltown / Centers
- Agricultural Hamlet
- School house
- Early Road
- Dam

MaclayArchitects
CHOICES IN SUSTAINABILITY

Energy in the Mill Era

MaclayArchitects
CHOICES IN SUSTAINABILITY

Agriculture in the Mill Era

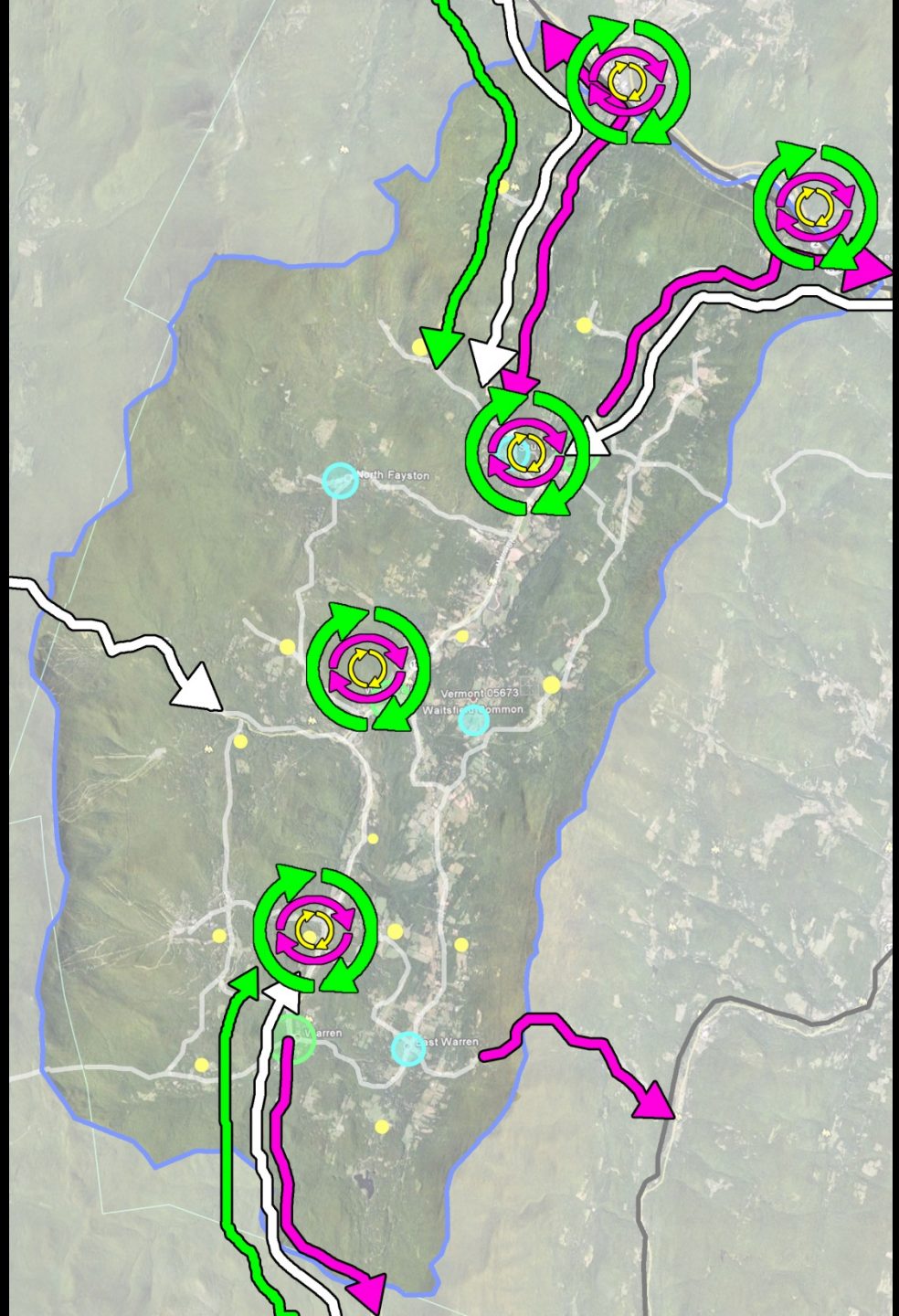
MaclayArchitects
CHOICES IN SUSTAINABILITY

Industry in the Mill Era

MaclayArchitects
CHOICES IN SUSTAINABILITY

Life in the Mill Era

MaclayArchitects
CHOICES IN SUSTAINABILITY



Flow: Milltowns

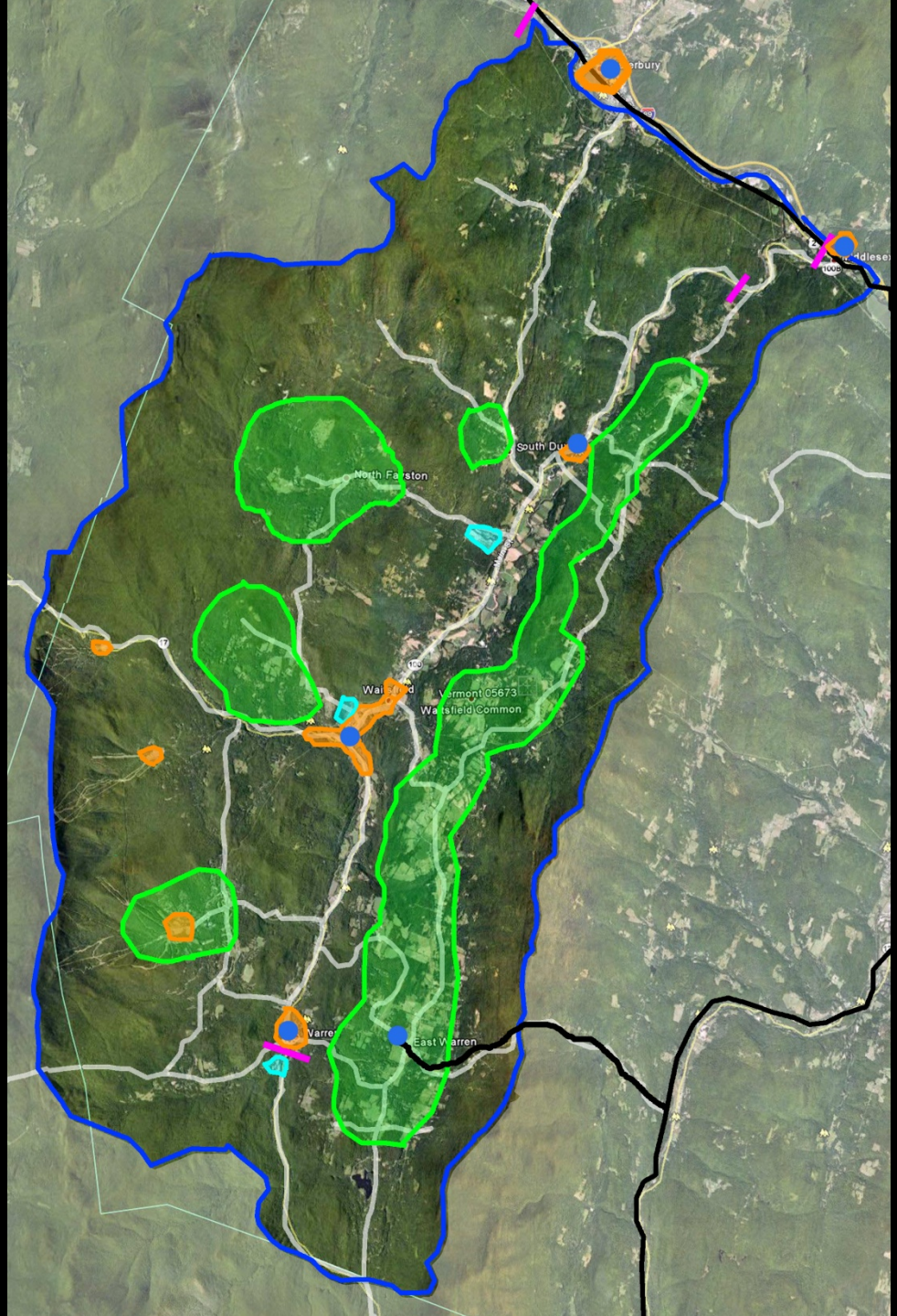
c. 1850 -1900

IN		OUT
	Energy	
→	Food	→
➡	Products	➡
⇨	Population	

MaclayArchitects
CHOICES IN SUSTAINABILITY

Land Use: Coal Era

c 1900 - 1950



- Commerce/Retail
- Products
- Agriculture
- Hydroelectric dam
- Roads
- Railroad
- Public Center

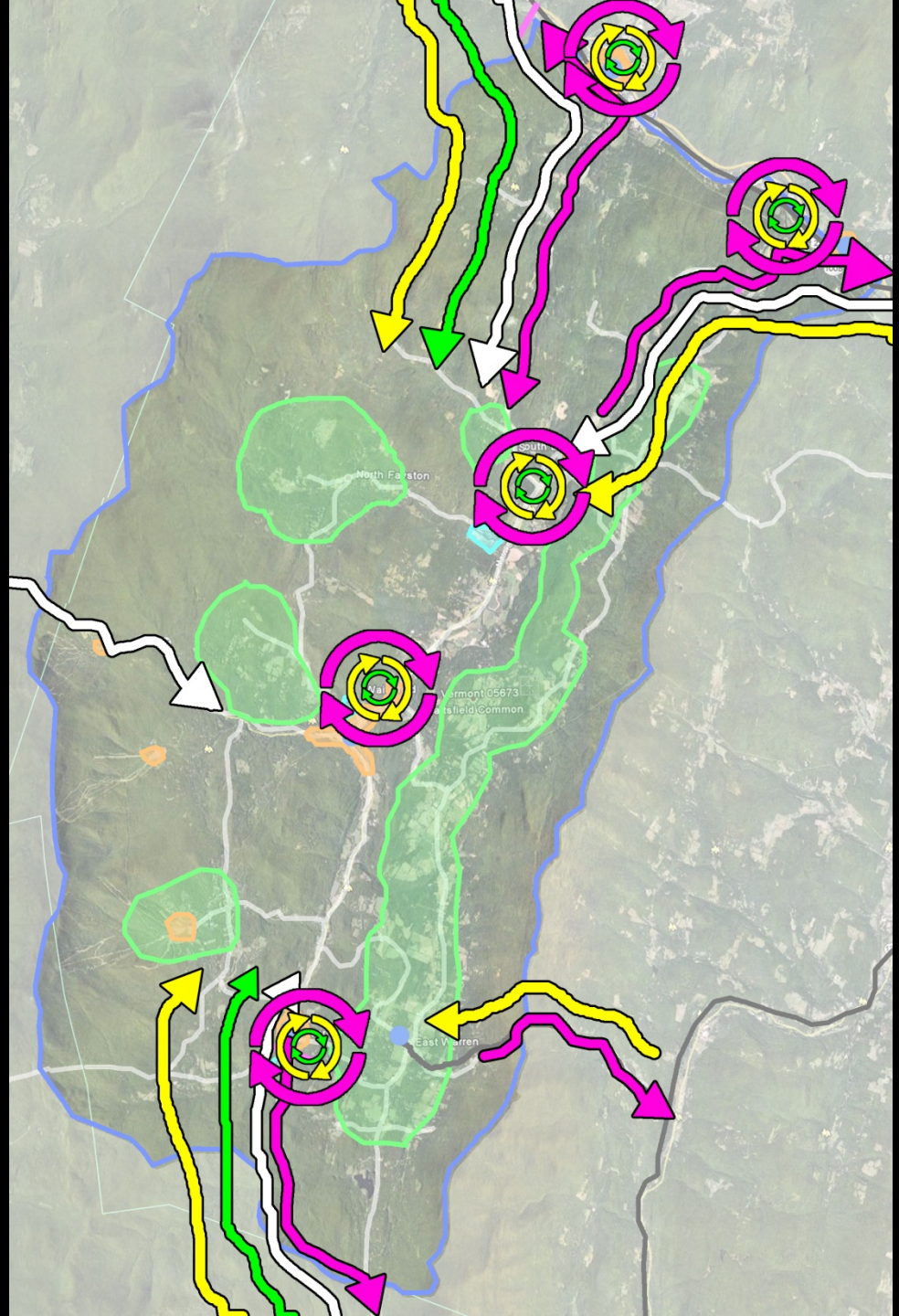
MaclayArchitects
CHOICES IN SUSTAINABILITY

Industry in the Coal Era

MaclayArchitects
CHOICES IN SUSTAINABILITY

Agriculture in the Coal Era

MaclayArchitects
CHOICES IN SUSTAINABILITY



Flow: Coal Era

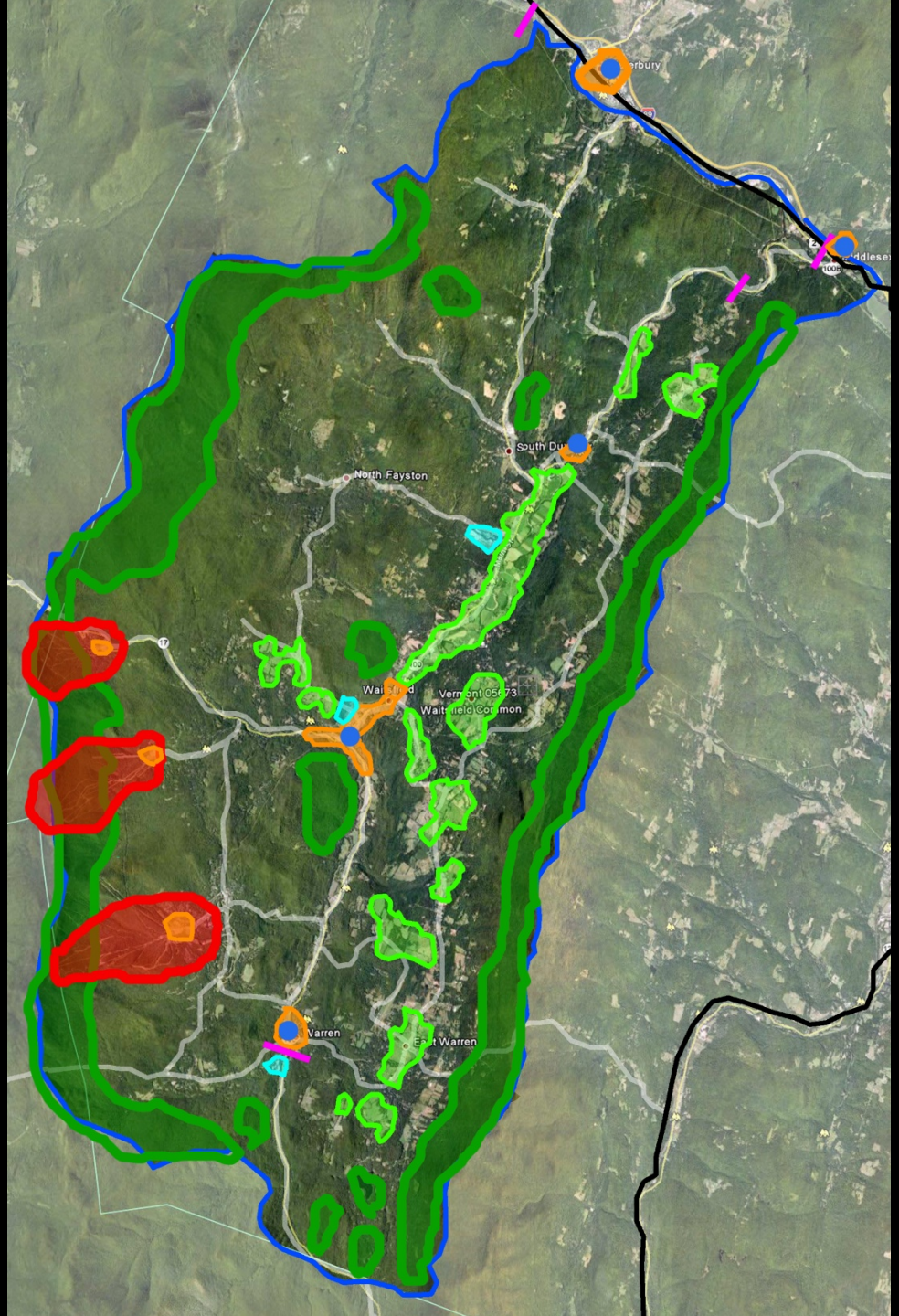
c. 1900 – 1950

IN		OUT
	Energy	
	Food	
	Products	
	Population	

MaclayArchitects
CHOICES IN SUSTAINABILITY

Land Use: Oil Era

c 1950 - 2010



- Commerce/Retail
- Products
- Agriculture
- Hydroelectric dam
- Roads
- Railroad
- Recreation
- Public Center
- Forests

MaclayArchitects
CHOICES IN SUSTAINABILITY

Transportation In the Oil Era

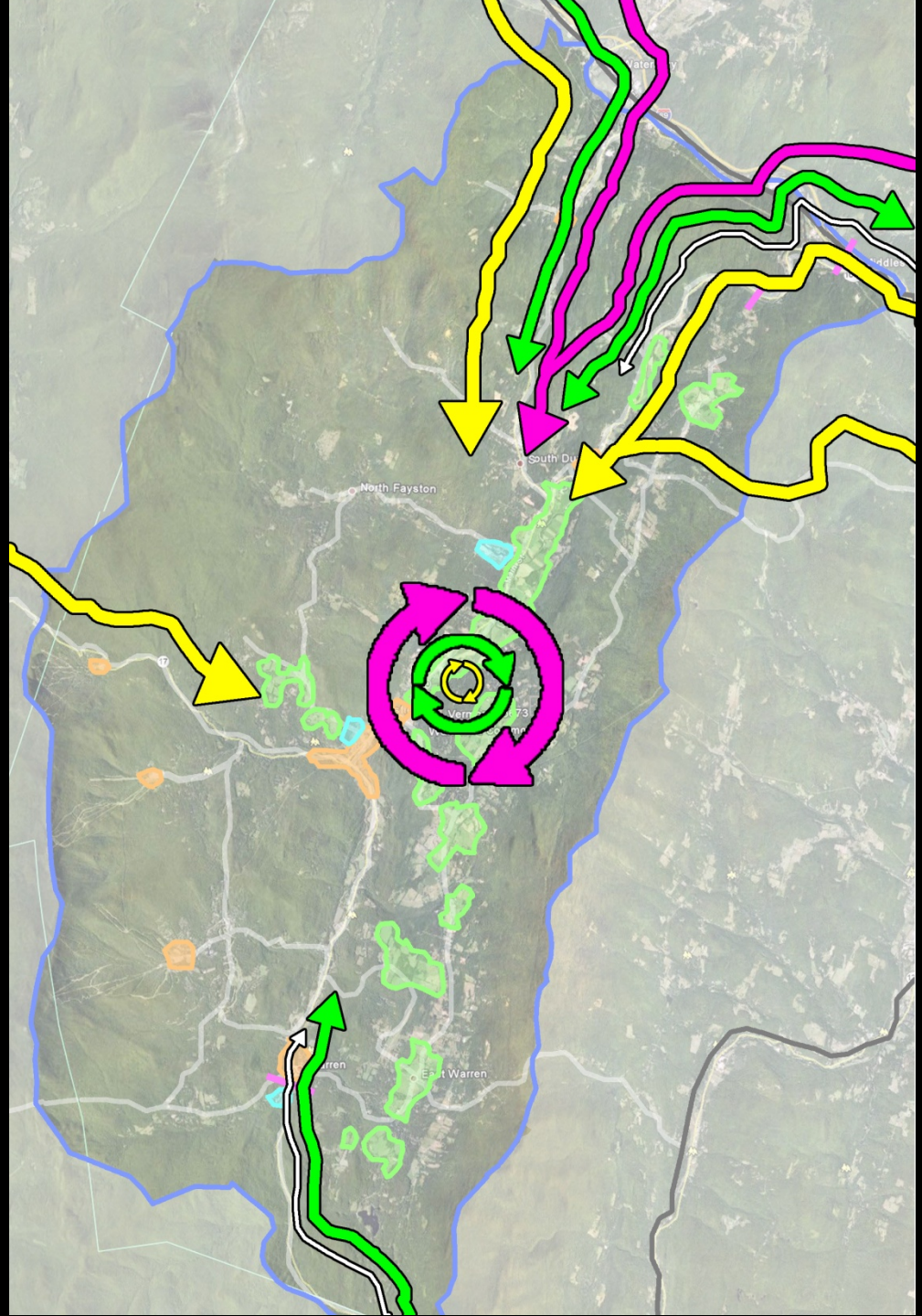
MaclayArchitects
CHOICES IN SUSTAINABILITY

Agriculture In the Oil Era

MaclayArchitects
CHOICES IN SUSTAINABILITY

Recreation in the Oil Era

MaclayArchitects
CHOICES IN SUSTAINABILITY

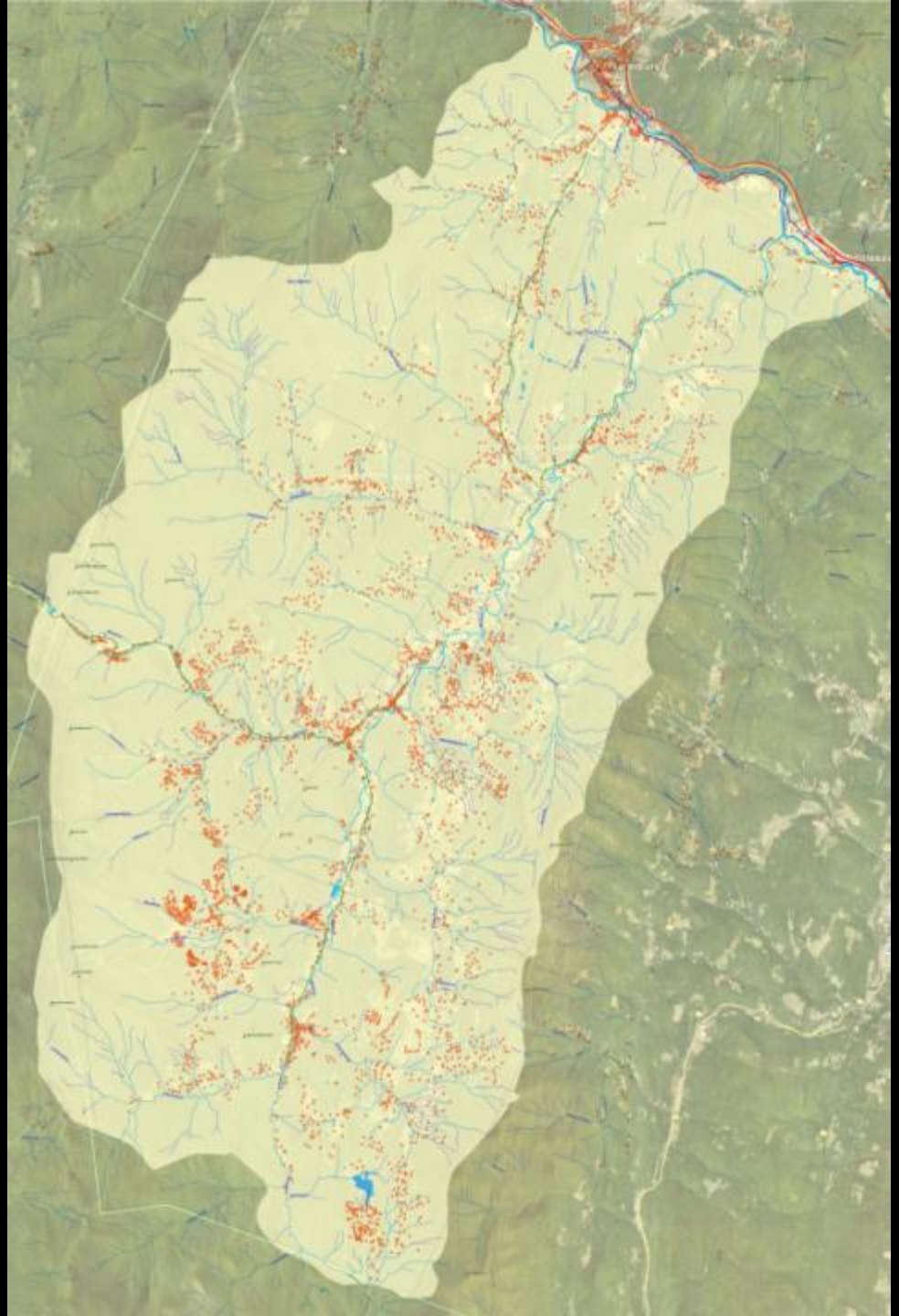


Flow: Oil Era

c. 1950 - 2010

IN		OUT
	Energy	
	Food	
	Products	
	Population	

MaclayArchitects
CHOICES IN SUSTAINABILITY



Settlement Patterns: Oil Era
All Building Locations

MaclayArchitects
CHOICES IN SUSTAINABILITY

What Will the Future Look Like?

- Rise in the cost of energy
- 80-90% reduction in energy consumption over typical building & community use
- On-site renewables power the buildings – smart grid
- Pedestrian communities, mixed use, local food, local industry, mass transit, community oriented

MaclayArchitects
CHOICES IN SUSTAINABILITY

What Will the Future Look Like?

MaclayArchitects
CHOICES IN SUSTAINABILITY

What Will the Future Look Like?

MaclayArchitects
CHOICES IN SUSTAINABILITY

What Will the Future Look Like?

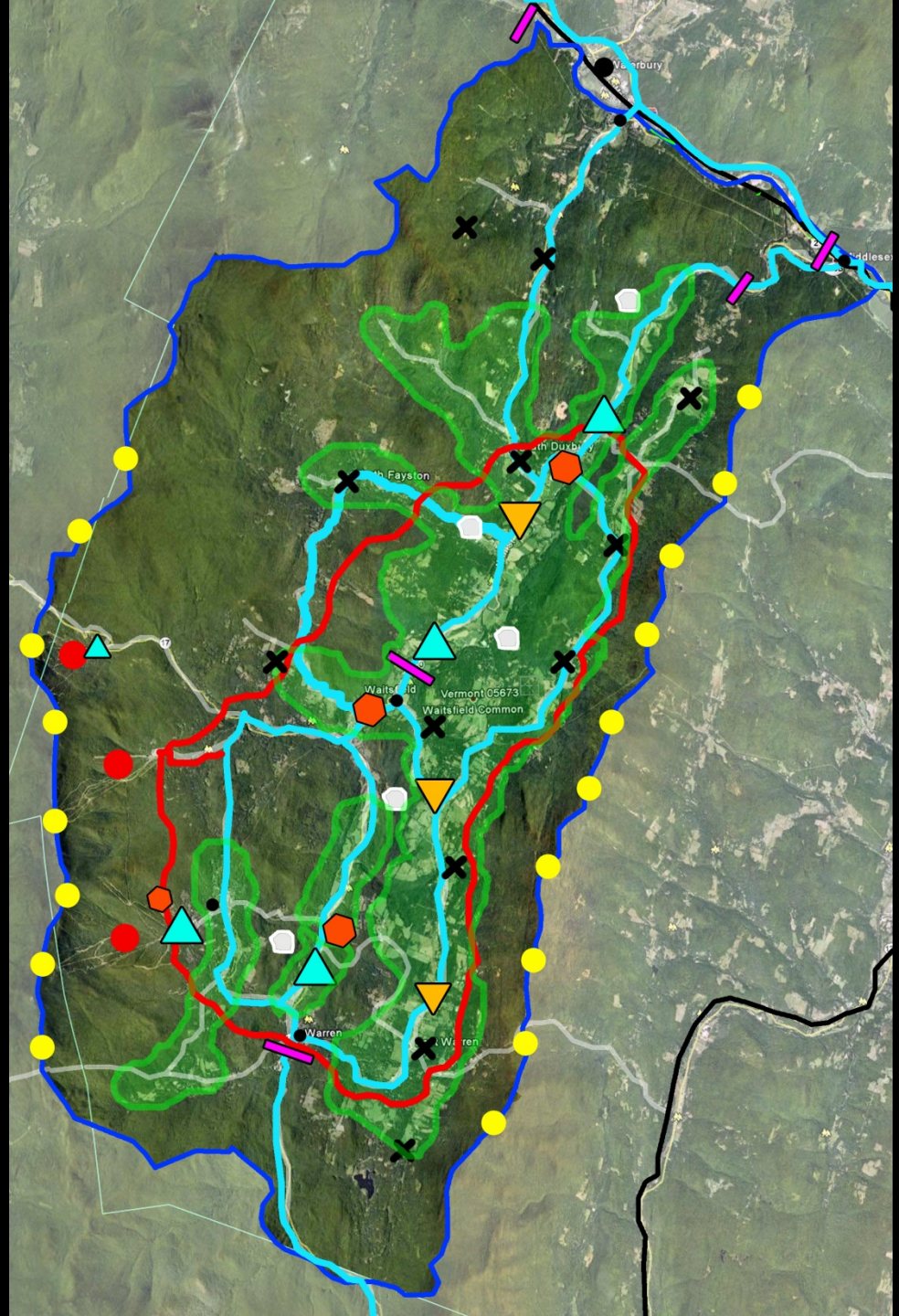
MaclayArchitects
CHOICES IN SUSTAINABILITY

What Will the Future Look Like?

MaclayArchitects
CHOICES IN SUSTAINABILITY

What Will the Future Look Like?

MaclayArchitects
CHOICES IN SUSTAINABILITY



Land Use: Renewable Era?

c. 2010 - ?

- Regional Center
- Village/Valley Centers
- Neighborhood Centers
- Wind Turbines
- Living Machines
- Methane Digesters
- District Biomass Heating
- Mass Transit Bussing
- Bike Path
- Recreational Center
- Hydroelectric Dam
- Photovoltaics
- Railroad
- Agricultural

MaclayArchitects
CHOICES IN SUSTAINABILITY

Energy in the Smart Renewable Era

Dispersed, renewably based

MaclayArchitects
CHOICES IN SUSTAINABILITY

Agriculture in the Smart Renewable Era

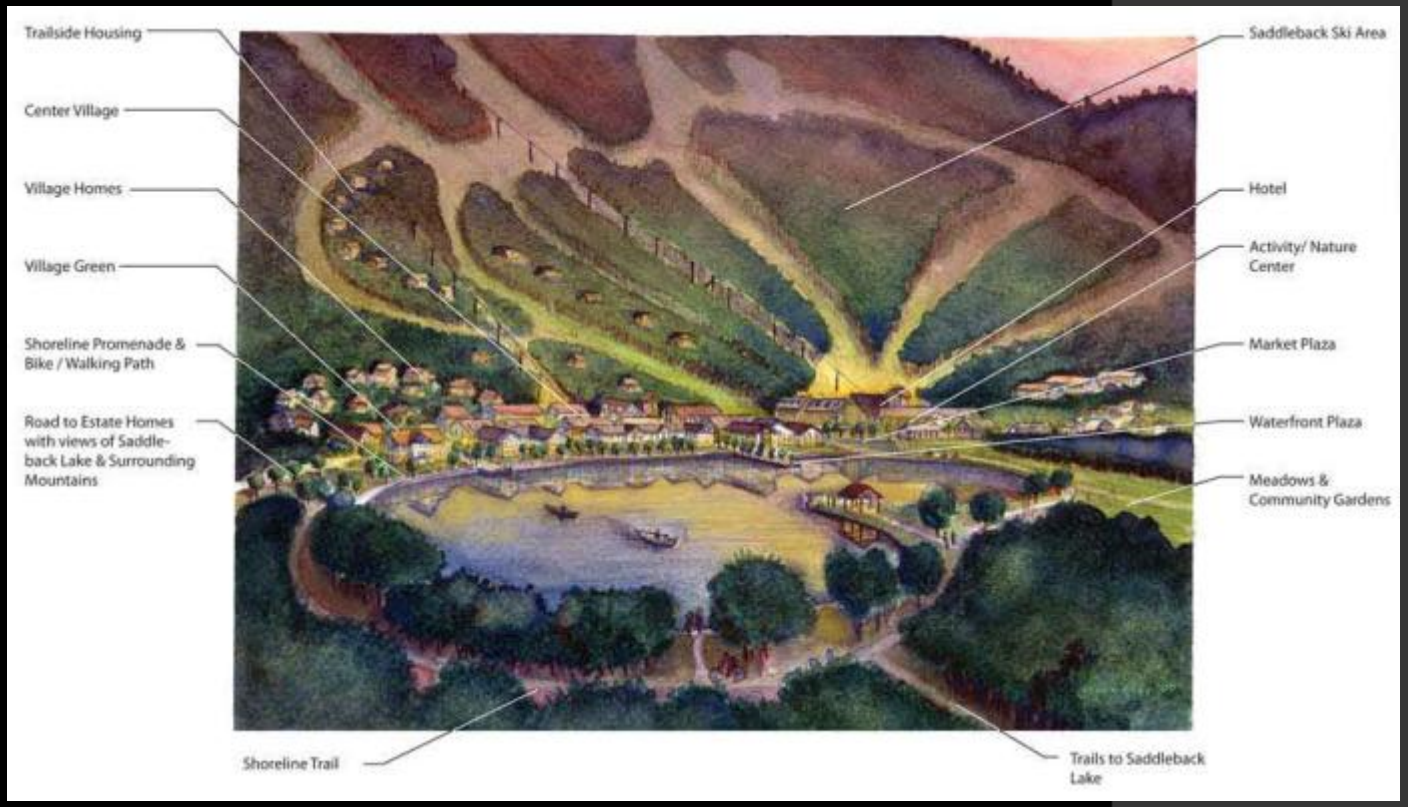
MaclayArchitects
CHOICES IN SUSTAINABILITY

Industry in the Smart Renewable Era

Natural Resource Based

MaclayArchitects
CHOICES IN SUSTAINABILITY

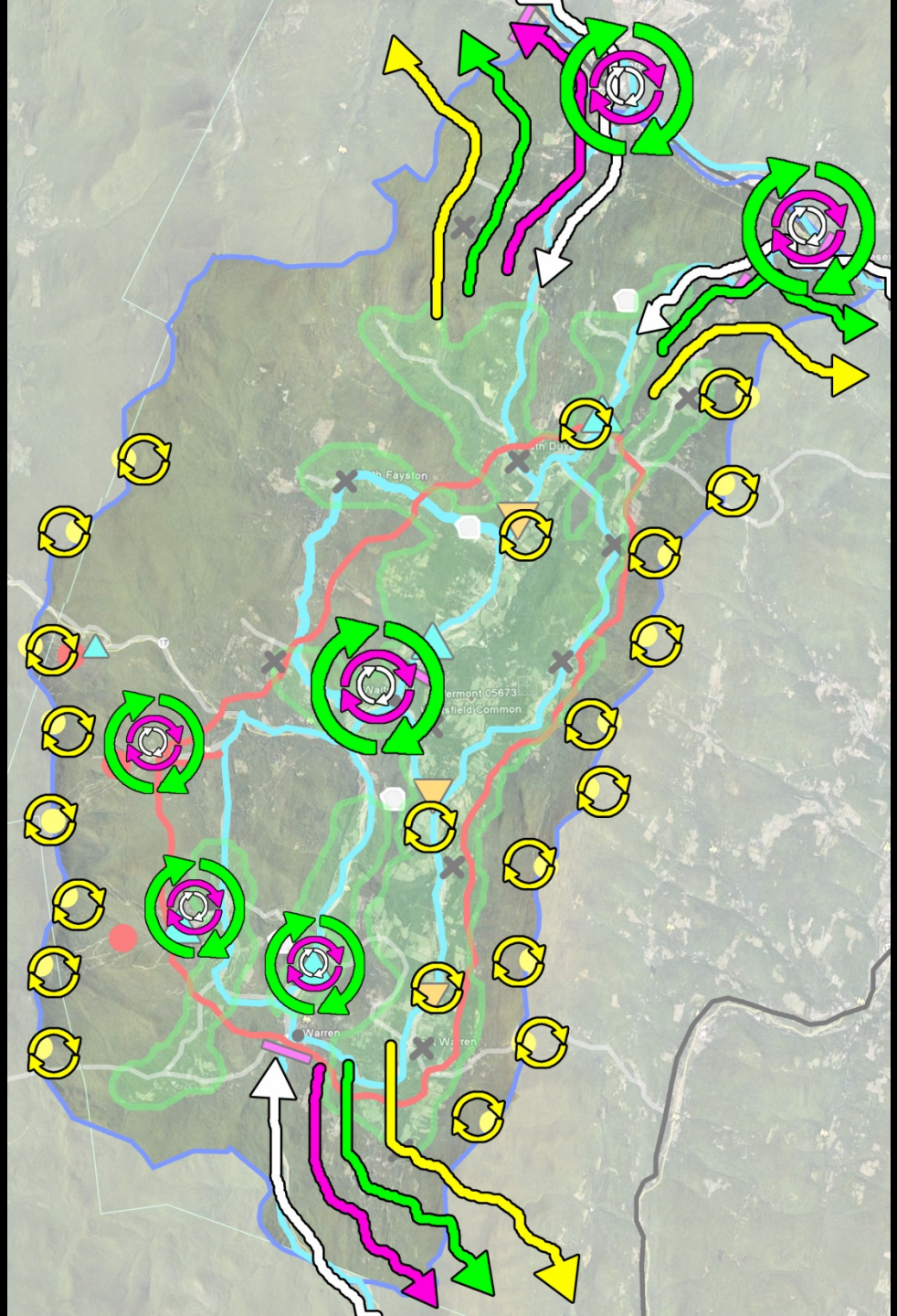
Recreation in Smart Renewable Era



MaclayArchitects
CHOICES IN SUSTAINABILITY

Transportation in Smart Renewable Era

MaclayArchitects
CHOICES IN SUSTAINABILITY



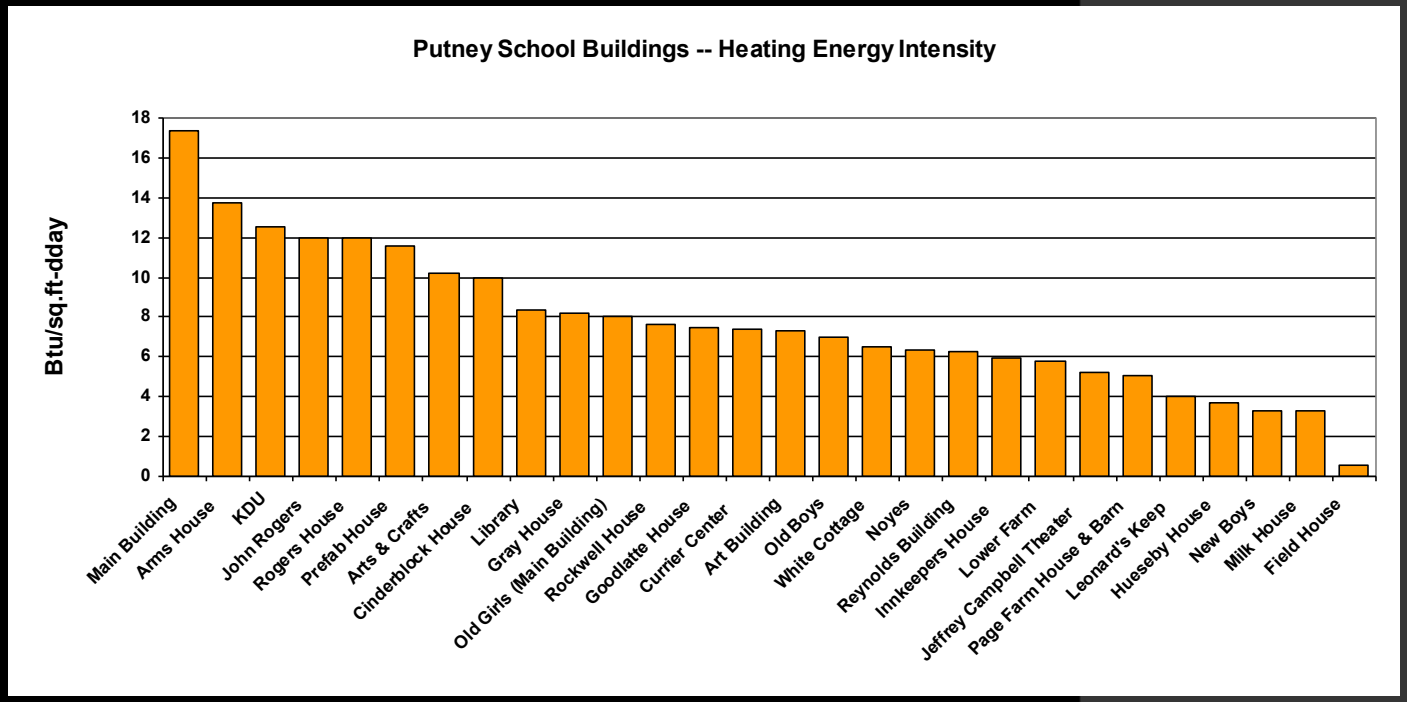
Flow: Renewable Era?

c. 2010 - ?

IN		OUT
	Energy	
	Food	
	Products	
	Population	

MaclayArchitects
CHOICES IN SUSTAINABILITY

A Net-Zero Putney School Campus



Phase	Cost for Efficiency Upgrades	Cost for BioMass Systems	Costs for PV's	Costs for Solar Hot Water	Costs for Air Source Heat Pumps	Total Cost
Phase One, Initial [1]	$ 1,850,000	$ 40,000	$ -			$ 1,900,000
Phase One, Final [2]	$ 7,400,000		$ 1,940,000	$ 70,000		$ 9,400,000
Phase Two [3]		$ 1,000,000	$ 1,940,000	$ 225,000	$ 96,000	$ 3,300,000
Phase Three [4]			$ 1,940,000		$ 2,675,000	$ 4,600,000
Total	$ 9,250,000	$ 1,040,000	$ 5,820,000	$ 295,000	$ 2,771,000	$ 19,200,000

MaclayArchitects
CHOICES IN SUSTAINABILITY

Estimating Energy Usage of the Mad River Valley – Path 1:

Total Electric Usage in the Mad River Valley
Residential & Commercial Customers

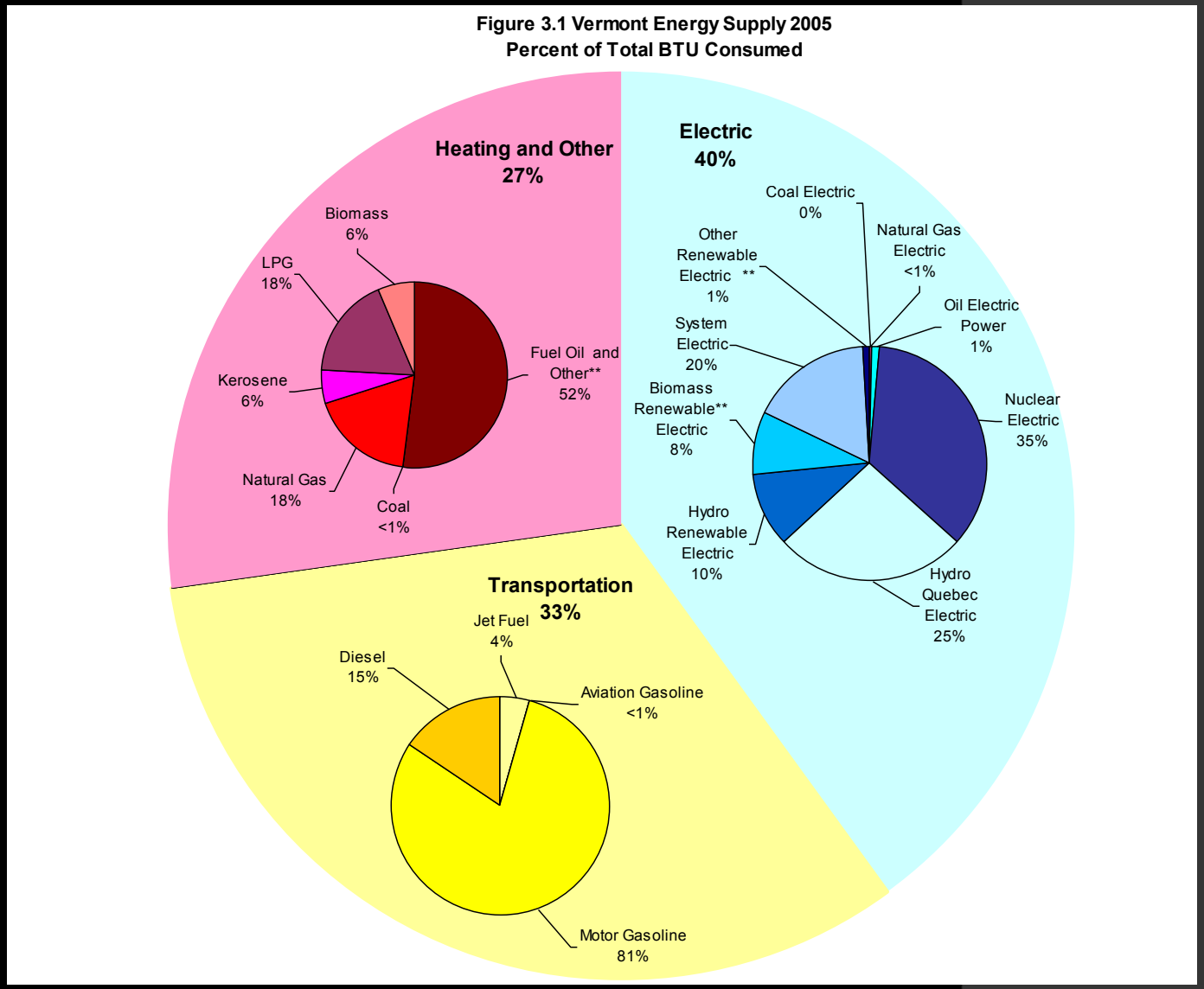
Fayston:	5,600,000 kWh
Moretown:	8,600,000 kWh
Waitsfield:	16,300,000 kWh
Warren:	35,900,000 kWh
Total MRV:	66,400,000 kWh

Vermont total electric usage = 5,852,165 MWh
MRV makes up only 1.1% of total VT electric usage

Sources: Utility Facts, 2008 by The Vermont Department of Public Service
Mad River Valley Electric Energy Usage from the Mad River Energy Study

MaclayArchitects
CHOICES IN SUSTAINABILITY

Estimating Energy Usage of the Mad River Valley – Path 1:



Source: Utility Facts, 2008 by The Vermont Department of Public Service

MaclayArchitects
CHOICES IN SUSTAINABILITY

A Net-Zero Mad River Valley

Total Energy Estimates for the Mad River Valley

Electric Load:	40%	66,400,000 kWh
Transportation:	33%	54,800,000 kWh
Heating & Other:	27%	44,800,000 kWh
Total Energy Load:		**166,000,000 kWh or 567,000,000 kBTUs**

Sources: Utility Facts, 2008 by The Vermont Department of Public Service
Mad River Valley Electric Energy Usage from the Mad River Energy Study

MaclayArchitects
CHOICES IN SUSTAINABILITY

Estimating Energy Usage of the Mad River Valley – Path 2:

Vermont Energy Usage per Capita = 254,500 kbtu or 74,568 kWh

** includes all energy sources: electricity, heating and transportation

Population of the Mad River Valley

Fayston:	1,240 residents
Moretown:	1,724 residents
Waitsfield:	1,692 residents
Warren:	1,729 residents
Total MRV:	6,385 residents

Total Energy Load: **476,000,000 kWh or 1,625,000,000 kBTUs**

Sources: EIA, Energy Consumption by Source and Total Consumption per Capita, Ranked by State, 2009

MaclayArchitects
CHOICES IN SUSTAINABILITY

Energy Usage of the Mad River Valley

MRV Total Energy Estimate Range:

Path 1 Estimates:	165,000,000 kWh or 562,000,000 kBTUs
Path 2 Estimates:	476,000,000 kWh or 1,625,000,000 kBTUs

Electricity:	66,000,000 kWh
Heating :	45,000,000 – 244,000,000 kWh
Transportation:	54,000,000 – 158,000,000 kWh

MRV Total Estimate:	**300,000,000 kWh or 1,025,000,000 kBTUs**

MaclayArchitects
CHOICES IN SUSTAINABILITY

A Net-Zero Mad River Valley

What does 300,000,000 kWh or 1.025 trillion kBTUs mean?

176,000 barrels of oil
73,000 cords of wood, 73,000 acres of woodland
256,400 kW of installed PV, 1500 acres or 2.4 square miles
36 wind turbines (2.3 Mw with 100 meter blades)
assuming a wind speed of 7.5 mps, requiring ridgeline placement

Sources: Utility Facts, 2008 by The Vermont Department of Public Service
Mad River Valley Electric Energy Usage from the Mad River Energy Study

MaclayArchitects
CHOICES IN SUSTAINABILITY

A Net-Zero Mad River Valley

With energy conservation we can realistically expect to reduce energy loads by around 25%.

We would then need:

132,000 barrels of oil
55,000 cords of wood, 55,000 acres of woodland
192,300 kW of installed PV, 1150 acres or 1.8 square miles
27 wind turbines (2.3 Mw with 100 meter blades)
assuming a wind speed of 7.5 mps, requiring ridgeline placement

Sources: Utility Facts, 2008 by The Vermont Department of Public Service
Mad River Valley Electric Energy Usage from the Mad River Energy Study

MaclayArchitects
CHOICES IN SUSTAINABILITY

Living Space Improvements for Energy & Flooding

Eliminate Food for Mold:

- Spray foam insulation
- Rigid insulation on wood and paper products

MaclayArchitects
CHOICES IN SUSTAINABILITY

Basement Improvements for Energy & Flooding

- Eliminate oil boilers
- Design for minimal flooding impact

MaclayArchitects
CHOICES IN SUSTAINABILITY

Sustainable Communities in a Net-Zero Mad River Valley

Is it really possible?

MaclayArchitects
CHOICES IN SUSTAINABILITY