THE

CLASH OF ENERGY SUPPLY AND CLIMATE CHANGE

Our energy infrastructure today

CATEGORIES	PRODUCTION	DISTRIBUTION	CONSUMPTION
Residential electricity and gas	Power plants, gas extraction and processing	Low voltage grid system Low pressure gas system	Heating systems, all appliances & lighting
Industrial electricity and gas	Power plants, gas extraction and processing	High voltage grid system High pressure gas piping	All industrial processes driven by electric motors, and engines and their Instrumentation.
Transportation	Oil wells, mines and Refineries	Pipelines, rail cars and refueling stations	Cars, trucks, train engines, ships, airplanes, conveyors, farm and mining equipment
Petrochemicals feed stock	Oil wells, mines and refineries	Pipelines and rail cars	Plastics, glues, paints, fertilizers, pesticides, herbicides, batteries and some 10,000 other products

Dr. Kua Harn Wei's rule

- Do not connect the dots and formulate premature decisions before you have all the dots available. Any mitigating proposal must be first evaluated by all the specialists in the applicable disciplines.

- Subject every mitigating proposal or idea to a rigorous Life Cycle Sustainability Analysis (LCSA), to define: (a) how the environment gets benefited, (b) by how much and (c) for how long.

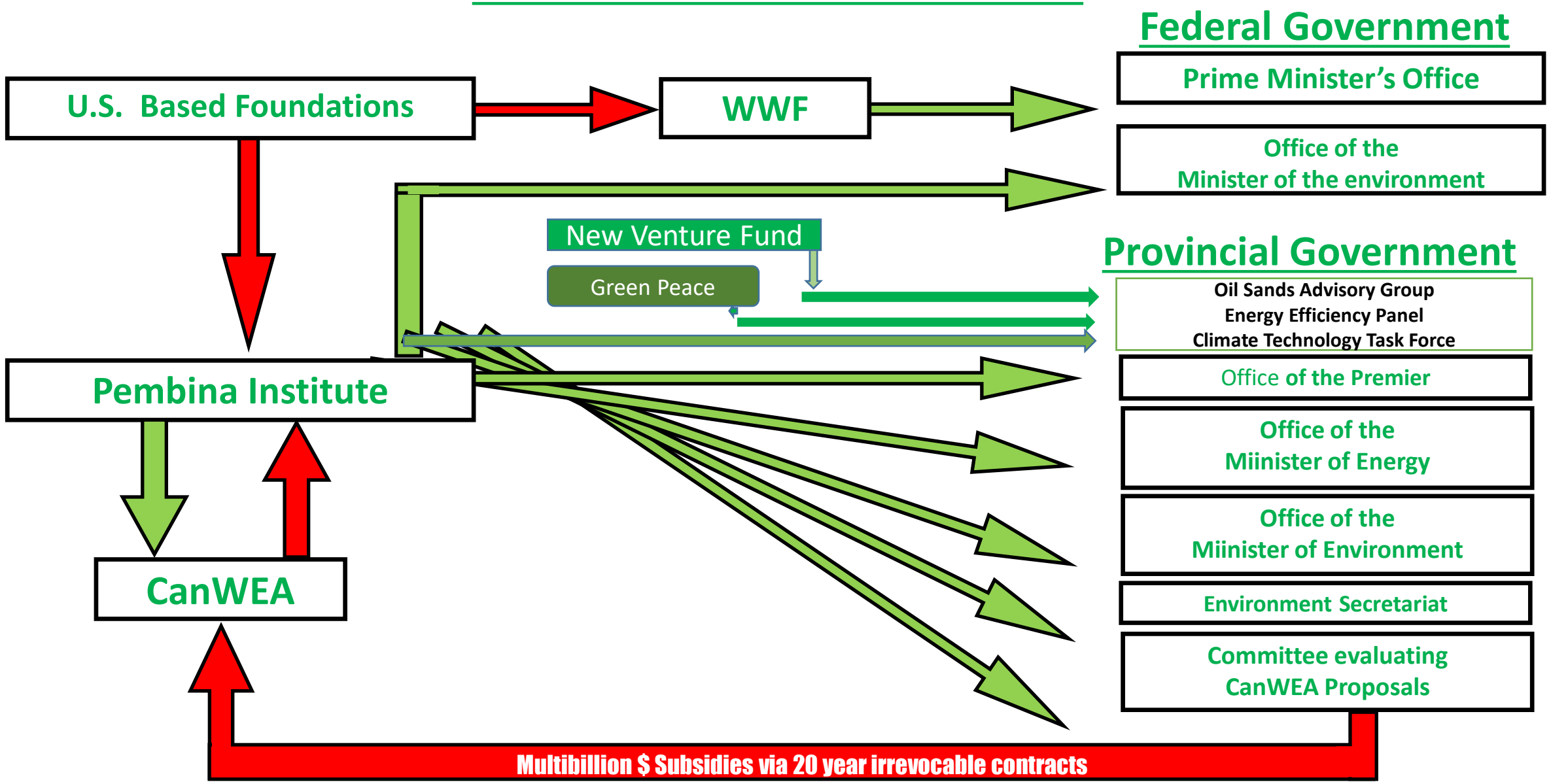
- Check if the mitigating project is scalable.

CO2 emissions in Alberta %

• Electricity production	17%
• Oil Production	46%
• Transportation	11%
• Agriculture/Forestry and Waste	9%
• Buildings and Homes	8%
• Industry and Manufacturing	9%
• TOTAL	100%

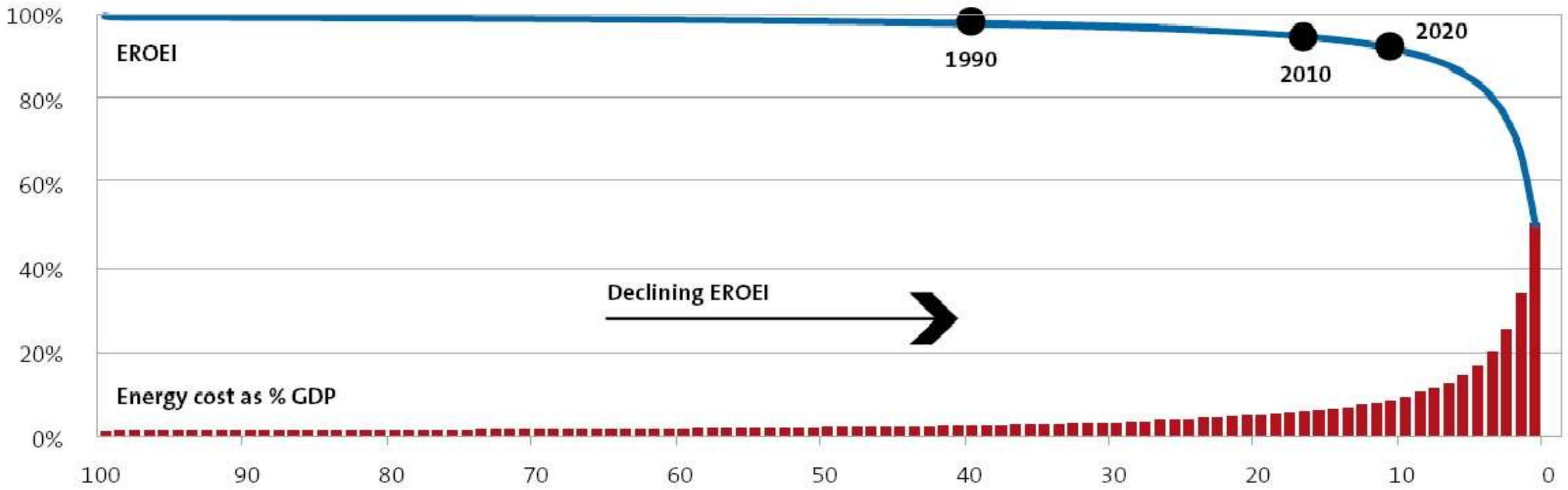
• Source: Alberta Climate Leadership Plan

FOXES IN ALBERTA's HENHOUSE



Declining EROEI and increasing cost of energy

Fig. 1.5: Nearing the energy returns cliff-edge*



Increased cost and declining EROEI

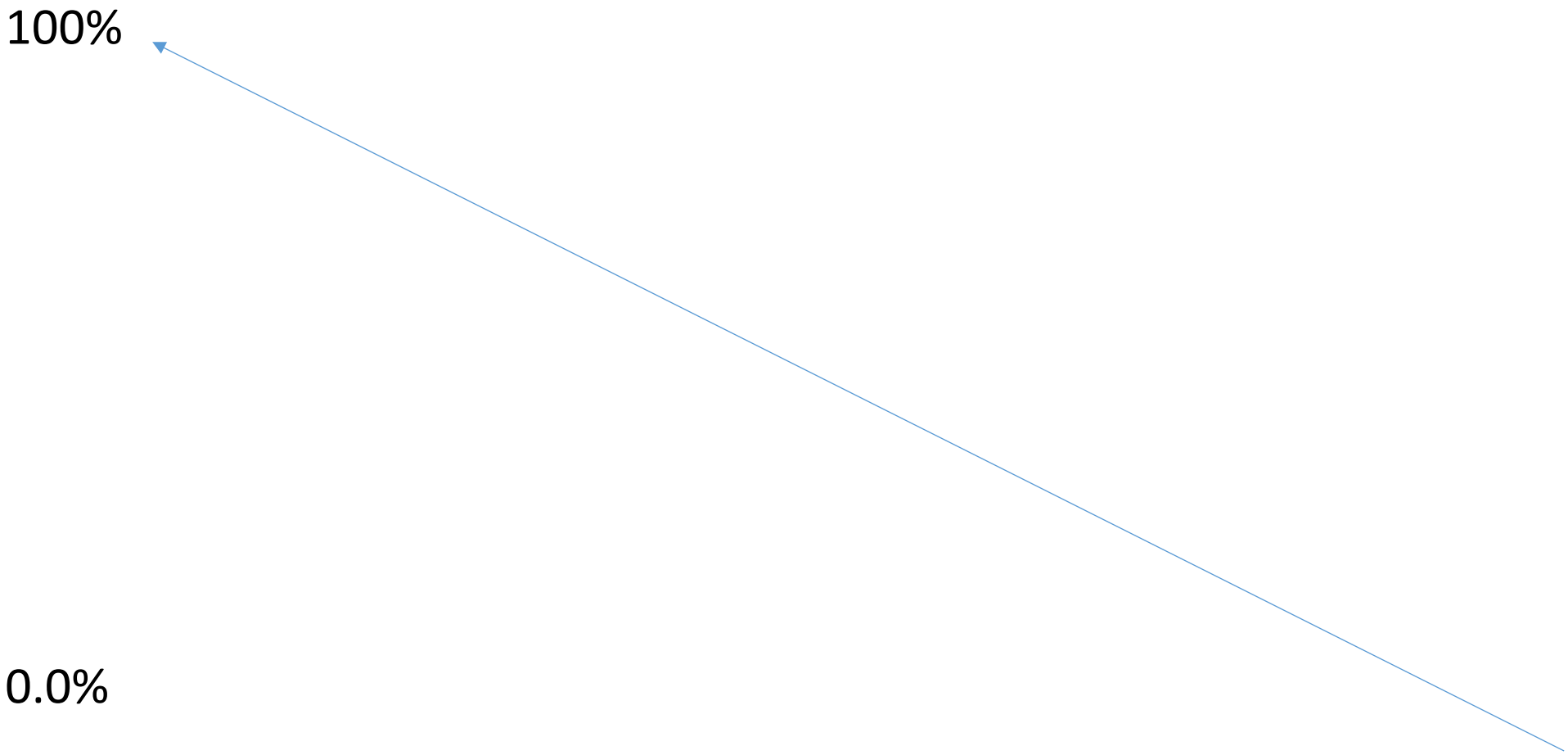
What is the best action for our environment and for humanity?

Reduce our energy consumption

Or

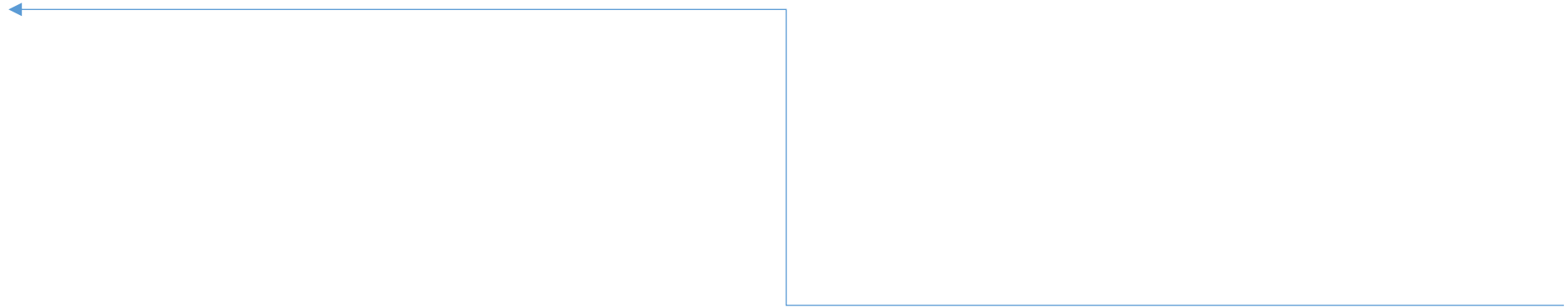
Replace our energy infrastructure

Replace our energy Infrastructure



Reduce our energy consumption per activity

- 100%



- 0.0%

Humanity and Energy

- Energy is essential to life and human understanding and use of energy is the essence of our success as species.

- Humanity has progressed rapidly when it mastered the use of higher density fuels and the country that achieved this became the superpower of that era.

Projected Earth Warming Under 2 different cases

Cause as per notes below	As we go now (A)	As this paper proposes (B)	Difference	Year	Year $^{-1}$
Constant 0.1^0/decade	+0.1	+0.10	0	2025	
Start Manufacturing	+0.1	+0.15	+0.05	2035	
Start building	+0.1	+0.15	+0.05	2045	
Continue construction	+0.1	+0.15	+0.05	2055	
Continue construction	+0.1	+0.15	+0.05	2065	
Finalize construction	+0.1	+0.15	+0.05	2075	
New Infrastructure ready	+0.1	0	-0.1	2085	
	+0.1	0	-0.1	2095	
	+0.1	0	-0.1	2105	
New infrastructure operates	+0.1	0	-0.1	2115	
New infrastructure operates					
New infrastructure operates					
New infrastructure operates					
TOTAL WARMING 2115	**+1.0 AND GROWING***	**+0.85 NOT GROWING**	**-0.15**	**2115**	

Examples of trial and error mitigation

- Tesla’s – electric cars
- Toyota’s – hydrogen cars
- Renewables are shadowed by fossil fuel – where are the CO savings?
- Nuclear Fusion – needs today’s reactors
- Replacing Coal-fired power plants with Gas fired = Continue at 50%

Examples of errors

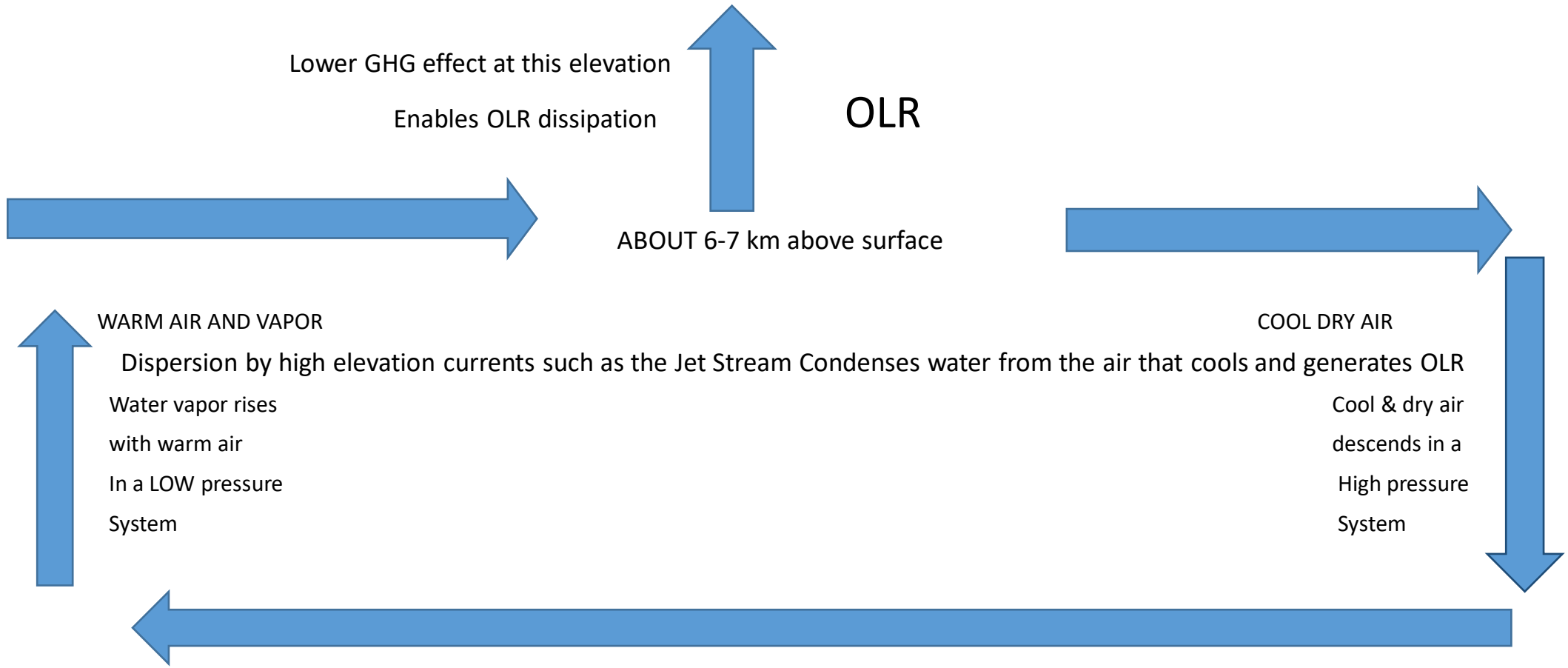
- Europe kick started this 25 years ago. Are we interested in their results today?
- China is exporting renewables. What is happening today?
- Since wind and sun is free and the cost of renewables is decreasing, why is the cost of electricity increases when renewables are installed?
- On energy matters are we good leaders or bad followers?
- When it comes to energy planning should we take LEAPS on the basis of ideologies by self glorified professors, or take careful and well thought out STEPS?

Environmental analysis of renewables

- Has anybody performed environmental assessment on renewable technologies?

- Both Solar and Wind technologies mitigate CO2.
- But do they also mitigate Earth warming?

Heat fluxes in an atmospheric Heat Pump



Water vapor/wind with harvested moisture enthalpy is condensation & lower kinetic energy

Figure 4 **Harvesting kinetic energy and enthalpy from the wind**

Looking Ahead

- Our use of fossil fuels for energy is unlikely to be sustainable for more than a few centuries, and maybe less depending on the importance of potential side effects such as climate change.

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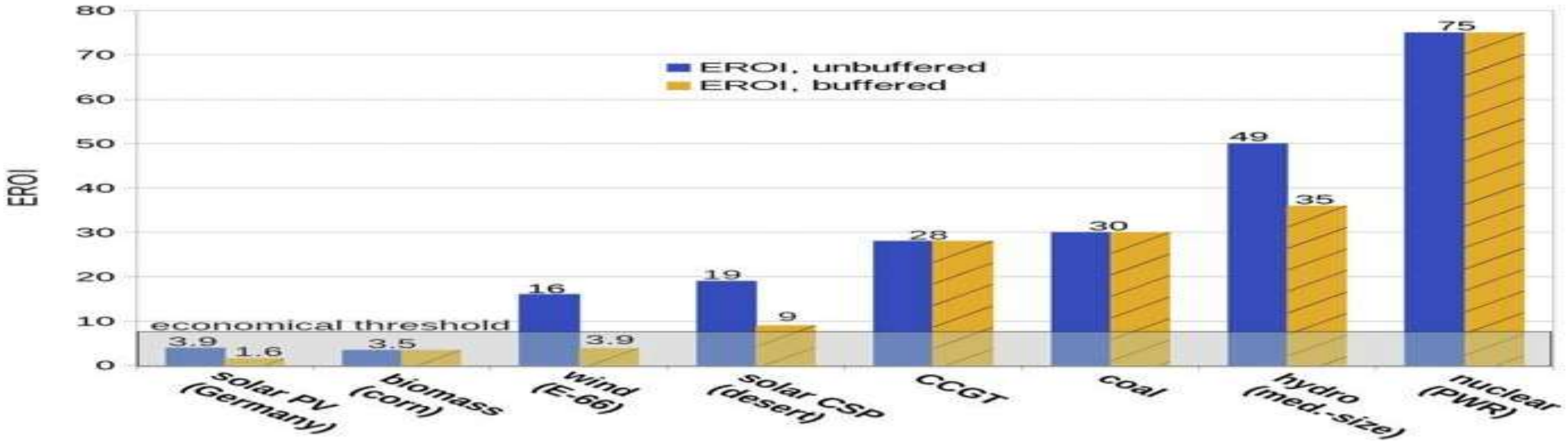
Our actions

- We need to seriously apply our understanding of energy, and the energy from fossil fuels, to develop rational alternatives
- This can be achieved by Engineering, Economic and Environmental Experts. (EEEE integrated teams)
- Our politicians have done their jobs quite well to set up the goals in the Paris Accord. Now is the time for EEEE groups to take over the selection of the elements and the planning of their implementation

One of the criteria needed to select technologies



Looking Ahead

- We know that our energy demand will be increasing by about 30% (?) to achieve the transition.
- We know that as fossil fuels approach depletion, during the next 200-300 Years, and as investors are divesting, the price of fuel will hit the roof.
- Should we focus now to achieve the transition, when hydrocarbons and other fossil fuels are plentiful and cheap?

Suggestion

- If we stop the hasty and uncritical decision making and invest a little time upfront as phase 1 of the big transition project, to educate ourselves of:
  - the fastest and most secure way to achieve the needed transition
  - build and test prototype systems for our energy infrastructure
  - develop dynamic simulators to investigate the AGW theory
  - begin implementation of the transition ensuring that we get it right the first time

  And develop an adaptive plan to ensure us with energy supply during the transition process.

Time considerations

- The sky is not falling
- We have the time to plan and implement it right the first time
- The total penalty of 0.2 degrees C increase for a 20 year delay is manageable
- The penalties of mistakes
  - Unnecessary Carbon releases to the atmosphere
  - Waste of resources (material, human and financial)
  - Unnecessary extra warming until the mistakes are corrected

  All will contribute more than the 0.2 degrees C warming of the moratorium

[11, 2] -- A Volumetric Analysis

Table 1

e earth's surface

** see reference [27] where it is calculated at 95%

Volumetric Composition of our atmosphere

GAS	Volume in Atmosphere (%)	Acts like a GHG by Absorbing/ and re-Emitting	Causes Major Feedback	GHG Effectiveness by volume (%)
Nitrogen N_2	78.0000	NO	NO	0.00
Oxygen O_2	20.0000	NO	NO	0.00
Argon AR	0.9300	NO	NO	0.00
Water Vapor H_2O	1.0000*	YES - STRONG	YES, positive & negative	96.00**
Carbon Dioxide CO_2	0.0390	YES – STRONG	YES, only positive	3.90
Methane CH_4	0.0003	YES - STRONG	YES, only positive	0.04

Spectroscopic analysis

	Wavelength of radiation (microns) 30] 'X' indicates peak absorption, 'nothing ' indicates regions with no absorption
Wavelength 0 to 20	
Vapor H_2O	Xxxxx........ xXxxxxx
CO_2	x X XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
CH_4	xXXXx x XXxxxxxxxxxxxxxxxxxxxxxxxx
CFC's	XXXXX
Incoming radiation	xXxxxxxxxxxxxx
Outgoing radiation*	xXXxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Effectiveness of Greenhouse Gases

	Elevation (Km)	Density (10^{-1}kg/m3)	Density %	GHG effectiveness (%)
Surface =	**0**	**12.250000**	**100**	**100**
Troposphere	**1**		**90**	**90**
Troposphere	**6**	**6.125000**	**50**	**50**
Tropopause =	**10**	**4.135000**	**33**	**3 ***
Stratosphere =	**50**	**0.010000**	**8**	**2 ***
Ionosphere =	**70**	**0.000184**	**0.1**	**<1 ***