<table>
<thead>
<tr>
<th><strong>Docket Number</strong></th>
<th>19-ERDD-01</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Title</strong></td>
<td>Research Idea Exchange</td>
</tr>
<tr>
<td><strong>TN #</strong></td>
<td>238088</td>
</tr>
<tr>
<td><strong>Document Title</strong></td>
<td>The Leighty Foundation Comments - Consider Novel, High-density, CarFree Urban Modules for Efficient Use of Land, Material, Energy</td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Filer</strong></td>
<td>System</td>
</tr>
<tr>
<td><strong>Organization</strong></td>
<td>The Leighty Foundation</td>
</tr>
<tr>
<td><strong>Submitter Role</strong></td>
<td>Public</td>
</tr>
<tr>
<td><strong>Submission Date</strong></td>
<td>6/2/2021 1:04:18 AM</td>
</tr>
<tr>
<td><strong>Docketed Date</strong></td>
<td>6/2/2021</td>
</tr>
</tbody>
</table>
Consider Novel, High-density, CarFree Urban Modules for Efficient Use of Land, Material, Energy

Please anticipate now millions of internally displaced persons (IDP's) fleeing rapid sea level rise, within a few decades, in CA and USA alone: where will we put them? What will we build for them that they, and we, can afford? Is this our opportunity to rectify USA's post-WW2 mistake -- building our cities for cars instead of for people? CEC should try, via a new GFO focused on this and / or similar concepts:
https://vimeo.com/373679728
"Designing â€œCarFreeâ€ Cities to Welcome Millions Fleeing Rapid Sea Level Rise, Within a Few Decades"

Many CEC and social equity objectives will be embraced by imagining and designing new mixed-density urban modules accommodating 100,000+ people, of loop topology based on concentric, contra-rotating fixed-guideway transit systems serving all accessibility needs for people and goods, while excluding all personal private vehicles from the "CarFree" urbanized area. CAPEX, OPEX, and land use would be greatly conserved. Many such urban "donut", "torus" shaped urban modules would necessarily be superimposed upon -- helicoptered down upon -- low-density regions of CA and USA cities, which includes most of the land areas, a "taking" of extant private property for which compensation is required: justified, in the context of the "Climate Change" emergency.

These "CarFree" loops would be built with best-practices conservation of materials and energy, water and land, attempting a "circular economy". People would walk and interact more than in today's USA urban life. Mental and physical health care savings might supply most of the needed capital. Savings in personal after-tax income required to own and operate several personal vehicles per family would service the balance of needed capital.

This will be a better investment than futile attempts to prevent loss of coastal property to rising seas, or dangerous attempts at geoengineering to reduce insolation upon Earth. We should now carefully consider such extraordinary responses to the unprecedented and imminent panoply of dangers self-inflicted by unrestrained anthropogenic GHG emissions, while we may still have time to act. California is probably the best place to start; CEC might lead, with EPIC or other funds.

Additional submitted attachment is included below.
Designing “CarFree” Cities to Welcome Millions Fleeing Rapid Sea Level Rise, Within a Few Decades

Bill Leighty, Director
The Leighty Foundation
Juneau, Alaska    USA
wleighty@earthlink.net
www.leightyfoundation.org/earth.php
907-586-1426       206-719-5554 cell
“Climate Change”

• Warming
• Severe weather
• Sea level rise
• Ocean acidification
• Species extinction
• Human conflict

Responses:
• Mitigation: cut GHG
• Adaptation
• Geoengineering
Greenland Ice Melting
Greenland Ice Melting
The Next Okies

- Another tragedy:
  - New “Dust Bowl”
  - “Global Climate Change” (GCC)
  - Displaced by rapid sea level rise
- Load the SUV, drive uphill, inland
- Lost real estate equity
- Welcome them: empathy
- National, global emergency
- Where put them?
- What build for them? What afford?
- Avoid sprawl
Why “Carfree, USA”?

• “Climate Change Emergency”: plan, design NOW
• Within a few decades
• Millions of Internally Displaced Persons (IDP’s)
• Unfortunates. Tragedy: Dust Bowl
• Real estate equity lost; homes, jobs lost
• Migrate upland, inland

New, complete, urban “Loop Communities” upon extant USA low-density cities: “city within a city”

<table>
<thead>
<tr>
<th>Helicopter down</th>
<th>Overlay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drop</td>
<td>Inflict</td>
</tr>
<tr>
<td>Impose</td>
<td>Envision, design, build, operate</td>
</tr>
</tbody>
</table>

Who will own, operate?
Who will live there? IDP ghettos?
**Why “Carfree” ?**

- “Climate Change Emergency”: plan, design NOW
- Millions of Internally Displaced Persons (IDP’s): 2100
- Real estate equity lost
- Migrating upland, inland
- Cannot afford tract home; we don’t want sprawl
- How accommodate? Where? What build?
- Anticipate, now: design, zone, comp plans, RFP
- “Access”, not “mobility”
- Lower capex: private, public
- Lower opex: private after-tax, public
- Lower “embodied” energy, materials = lower GHG
- Recover from post-WW2 mistake:
  
  designed for cars, not people → **Opportunity**
New York Scenario 2100
Unconstrained fossil fuel combustion

Source: https://choices.climatecentral.org/#12/40.7117/-74.0010?compare=scenarios&carbon-end-yr=2100&scenario-a=unchecked&scenario-b=extreme-cuts
New York Scenario 2100

Extreme carbon cuts

Source: Climate Central 29 Oct 2019

Source: https://choices.climatecentral.org/#12/40.7117/-74.0010?compare=scenarios&carbon-end-yr=2100&scenario-a=unchecked&scenario-b=extreme-cuts
San Diego
Scenario 2100
Unchecked pollution
Very difficult to predict

Source:
Climate Central
29 Oct 19

Source: https://choices.climatecentral.org/#7/15.882/100.981?compare=scenarios&carbon-end-yr=2100&scenario-a=unchecked&scenario-b=extreme-cuts
San Diego
Extreme carbon cuts
Scenario 2100
Very difficult to predict
Source:
Climate Central
29 Oct 19

Source: https://choices.climatecentral.org/#7/15.882/100.981?compare=scenarios&carbon-end-yr=2100&scenario-a=unchecked&scenario-b=extreme-cuts
**Bangkok**
Unchecked pollution
Estimated date: 2100
Very difficult to predict

Source: Climate Central

Source: https://choices.climatecentral.org/#7/15.882/100.981?compare=scenarios&carbon-end-yr=2100&scenario-a=unchecked&scenario-b=extreme-cuts
Bangkok
Extreme carbon cuts
Estimated date: 2100
Very difficult to predict
Source: Climate Central

Source: https://choices.climatecentral.org/#7/15.882/100.981?compare=scenarios&carbon-end-yr=2100&scenario-a=unchecked&scenario-b=extreme-cuts
Land at risk of inundation by year 2100: Thailand
Land at risk of inundation by year 2100
1. Autonomous Vehicles (AV’s) -- “self-driving”
2. Shared mobility: Transportation Network Companies (TNC)
   -- Uber
   -- Lyft
3. Electric vehicles: (all sizes)
   – Battery Electric (BEV)
   – Fuel Cell (FCV), hydrogen fueled hybrid electric

Panacea ?
Help with sea level rise emergency ?
What is “Carfree, USA”?

- Complete necklace of “Villages” dropped on low-density US cities
  - Complete “city within, upon, a city”
  - Diverse
  - Most services
- No: -- Personal vehicles in urbanized areas
  -- Parking lots or structures
  -- Driveways, garages
- 100,000 + people
- Density high, stress low
- Low COL (cost of living)
- New urban lifestyle
- New urban topology
- Prevent sprawl
- Personal vehicles stored
What is “Carfree, USA”?

• Efficiency:
  – Land, habitat
  – Energy
  – Materials
  – Time: everyone

• Replicate:
  – Many US cities
  – Intersect, as needed
  – Prevail in USA? Beyond?
  – Replace “car culture”
“Village” node

- Typical; unique
- Transit station centric
- Build “Community”
- Dominant use varies
- Influence envelope
- Pavement
- No private LDV’s
- No “parking”
- No driveways
- No garages
- TAAS
- TNC’s
- More “Access”
- Less “Mobility”
- Pearls on necklace

**TAAS:**
Transportation As A Service

**TNC:**
Transportation Network Company
(Uber, Lyft)
**What is “Carfree”?**

- Response to national, global emergency: rapid sea level rise
- New urbanity “imposed” upon extant cities
  - Low-density regions
  - Overlay
  - Helicopter down
- “Taking” of private property
- High-density
- No private personal vehicles in urbanized areas
- Topology: loop, donut, torus
- Station-centric “village” nodes
- “Access” via contra-rotating fixed-guideway transit, stations @ 500 m
- Light rail, streetcar, hybrid:
  - Electric drive
  - On-board Hydrogen or battery energy
- Passengers, packages, mail, freight – UPS, FEDEX, other
- Paving:
  - Walk, bike
  - Service vehicles
  - Emergency vehicles
What is “Carfree”?

- Rapid Response to national, global emergency: rapid sea level rise
- Conceptual template
- Planned community: many examples
- “Access” replaces “Mobility”
- Peripheral parking for personal vehicles

Complete necklace of “Villages” dropped on low-density US cities
  - Complete “city within, upon, a city”
  - Diverse
  - Most services: max “access”
Benefits, Costs

Benefits:
- Walk, bike more: healthier, reduce all health care costs
- Lower COL (cost of living): Lower --
  - Private vehicle ownership
  - Private after-tax expense
  - Lower public capex, opex
- Reduce greenhouse gas (GHG) emissions:
  - Transportation
  - New buildings
  - Lower embodied energy
- Avoid sprawl
- Envelope influence effect: car-independence propagates outward
- Enhance human contact; community → Happiness

Investments:
- Taking private property: eminent domain
- Transport system: fixed guideway loops, rolling stock, stations
- Other infrastructure: utilities, village paving
Benefits, Costs

Costs:

Reward-to-Risk ratio:
Designing Carfree, USA
Very complex: start NOW

- Recruit, select host cities: reception, permitting
- Verify market: finance?
- Topology: Transportation system loop
- Loop diameter, village diameter
- Right-of way, footprint, influence envelope
- Population target
- Schedule: urgent
- Compose RFP; RFQ. Design-Build? Operate?
- Finance: costs, cash flow, reward: risk
- Success motivates:
  - Car-independent living propagates beyond loop
  - Greater devotion to mitigation
Design: New cities are rare

Superordinate Goals: Total Human Enterprise
- Total decarbonization
- Total de-GHG
- Earth well-being
- Species survival

Problem:
- “Climate Change”
- Sea level rise
- Emergency

Responses:
- Mitigation
- Adaptation
- Geoengineering
- Denial, acceptance, faith

Adaptation:
Aspects, criteria, goals:
- Local, regional
- National, continental
- Global, biosphere, Gaia
- Short, long term

Criteria, considerations:
- Fix post-WW2 mistake: cars
- Human community
- Earth, biosphere community
- Natural capital
- Financial capital
- Land use
- Topology
- Transportation
- Climate
- Food, water
- Government
- Private sector, business
- Personal

Designing Car-free Cities to Welcome Millions Fleeing Rapid Sea Level Rise

Output: RFP
Des Moines, IA
Surrounded by world’s best farmland
“Climate Change”
- Warming
- Severe weather
- Sea level rise
- Ocean acidification
- Species extinction
- Human conflict

Responses:
- Mitigation: cut GHG
- Adaptation
- Geoengineering
“There’s a better way to do it ... Find it”

Thomas Edison
Solar Hydrogen Energy System

Think: systems engineers

Perpetual motion?
Free storage?

Sunlight from local star

Electrolyzer
Fuel Cell

Electricity

H₂
O₂

Work
Transform Entire Human Enterprise

• Our responsibility, obligation
• “Climate Change” emergency
• All human activity
• Near-total de-carbonization (CO₂)
• Near-total de-GHG-emission
• Enormous business opportunity

FOCUS: Transform world’s largest industry
Energy: Greatest Humanitarian Gift

- Gaia, species, systems, peoples
- Global energy system: achieves all --
  - Benign
  - Relatively safe
  - Inexhaustible
  - Affordable: competitive
  - Preserve natural capital: Earth
  - Firm and dispatchable
  - Storage inherently free
  - Resilient, robust: acts of God and man
  - Cyberattack resistant
  - Unobtrusive infrastructure
  - Equitable: no monopoly
  - Distributed, autonomous
  - Ubiquitous on Earth
Transform Entire Human Enterprise

• Humanitarian: prevent climate catastrophe
• Beyond energy, transport, electricity
• All human activity: “enterprise”
• Transform world’s largest industry:
  • Quickly
  • Prudently
  • Profitably
• Peak energy ~ 2030  640 EJ =
• Efficiency up
• Fossil fuels:  81 % → 56 %  2050
World Primary Energy Consumption

BP Energy Outlook To 2035

January ‘14

Billion tons of oil equivalent (toe)

Renewable, Hydro, Nuclear

Coal

Gas

Fossil

Oil

1965
2000
2035
Dr. Fatih Birol, IEA Executive Director:
- “... crystal clarity ... there is no single or simple solution to transforming global energy systems.”
- “Without new policies in place, the world will miss its climate goals by a very large margin.”

Tomorrow’s energy supply drivers:
- Shale revolution
- LNG (liquefied natural gas)
- Falling costs of renewables
- Digital technologies

What is the world pathway to meet global climate targets and other sustainable energy goals?

Africa: affect global trends?
- What energy choices
- Rise of consumers

Offshore wind: How large?

Could world's gas grids deliver low-carbon energy?
Transform World’s Largest Industry

Complete energy systems:

• Renewable energy (RE)
• CO2-emission-free (CEF)
• Multiple sources
• Variable generation (VG): Time-varying output
• Integrated, synergistic
• Electrochemical or Carnot?
• Move, store, as electricity or as water-split Hydrogen?
  ▪ Electrochemical: “electrolyzer” proven
  ▪ Photochemical: catalyst
  ▪ Biochemical: photosynthesis
  ▪ Thermochemical: High-T solar, nuclear
• Lower Dispensed Cost: Wind-source Hydrogen Fuel

Entirely via electricity systems?
Danger: All eggs in electricity basket?

Error

BUSTER WAS CAUGHT BARKING UP THE WRONG TREE AGAIN.

"Climate Change"

Barking up the wrong tree!
“Grid”

Technically, Economically Suboptimal?

Obsolete?

Opportunity cost to persist?
Mitigation: USA, Global, Local
Don’t give up

• Quickly reduce, then zero, ALL anthropogenic greenhouse gas (GHG) emissions
• Transform the world’s largest industry from ~ 85% fossil to ~ 100% renewable, CO2-emission-free energy sources, as quickly as we prudently and profitably can
• Run the world on renewables
• Resist “adaptation” and “geoengineering”

1. Complete, integrated, optimized, CO2-emission-free energy systems based on C-free fuels – Hydrogen (H2) and Anhydrous Ammonia (NH3) – via pipelines

2. Deep (6 - 10 km), hot dry rock (HDR) geothermal via Electro Pulse Boring (EPB), to go deep enough, cheap enough, almost anywhere on Earth
"There's a better way to do it ... Find it"

Thomas Edison
The Great Plains Wind Resource

Continental scale
Total solar: $\sim 3 \times 10^{14} \text{ kg/yr}$
Total wind: $\sim 3 \times 10^{11} \text{ kg/yr}$

Synergy:
- Diurnal + Seasonal
- Minimize “firming” storage
Zion, IL
Near Zion nuclear plant, Oct 02
Vulnerable to acts of God and man
Think: systems engineers

Sunlight from local star

Perpetual motion? Free storage?

Solar Hydrogen Energy System

Electricity

Electrolyzer

O₂

H₂

Fuel Cell

Work

2H₂O + Energy → 2H₂ + O₂

2H₂ + O₂ → 2H₂O + Energy

www.H-TEC.com
Hypothesis:
- Limit elec to “first & last km, m” of energy system
- C-free fuels between: pipelines, low-cost storage

How to know? Who will model, study, propose?
- Urgent!
- Prevent opportunity costs: wasted capital → Grid invest
- Collaborative + funding
- Optimum mix, strategy
Hydrogen Energy Storage

1,000 miles Hydrogen Gas Pipeline 36" diameter, 1,500 - 500 psi

Pipeline Storage = 120 GWh

Wind Generators
Electrolyzers

Generators
ICE, CT, FC

Storage

Endusers
Retail

AC grid Wholesale

Cars, Buses, Trucks, Trains

Storage

Liquefy

Aircraft Fuel

Storage

Geologic Storage?
GH2 Transmission Pipeline

Wind Potential ~ 10,000 GW
12 Great Plains states
8,000 MW alternatives: HVAC vs Hydrogen Pipeline

Gaseous Hydrogen Pipeline
36” diam, 25 ft ROW

600 ft ROW

Out of Sight, Out of Harm’s Way
Wind Seasonality, Northern Great Plains

1,000 MW windplant: $\text{AEP} = 3,500 \text{ GWh} / \text{yr}$

“Firm” goal = 875 GWh / season

Storage: 320 GWh per 1,000 MW wind

Source: NREL, D. Elliott
Hydrogen Caverns in Texas
- Chevron-Phillips 25 years
- Praxair 6 years

Each:
90 GWh
$15 million capex
$0.20 / kWh
Li-Ion battery production (Bloomberg)

Global total 2017 = 103 GWh / year
Global total 2021 = 278 GWh / year

- Hydrogen: 1 salt cavern @ $15-20 million = 90 GWh
- Ammonia: 1 liquid tank @ $15-20 million = 200 GWh
Annual Income

Where should we invest for the long-haul??

World energy use

©Richard Perez, et al.

Capital: ROI

Deep (6-10 km)
Hot Dry Rock (HDR)
Geothermal
Electro Pulse Boring

- Deep geothermal heat: 240°C @ 8 km
- Electricity + DHS heat, anywhere
- Low-cost rock breaking in tension
- “Deep enough, cheap enough”
- No rotary abrasive drilling; drill rig?
- Goal: $150 / m, 50 cm diam, 5-10 km
- Hose return cuttings to surface
- Casing only through topsoil, aquifers

Thermosiphon:
Greatly reduced pumping cost.
No fracking at depth.
“Americans can be counted on to always do the right thing – but only after they have tried everything else.”

Winston Churchill

The dog caught the car.

Dan Reicher
Far more Ambitious:

- **Unacceptable scenarios:** better, faster
- Renewables industry
- Beyond electricity systems
- Transportation + CHP fuels
- Hydrogen + ammonia fuels
- Run the World on Renewables
- ~100% GHG-emission-free energy
- ~100% GHG-emission-free enterprise
• Peak energy ~ 2030  640 EJ =
• Efficiency up
• Fossil fuels:  81 % → 56 %  2050
World Primary Energy Consumption

BP Energy Outlook To 2035

January ‘14
“Climate Change”
- Warming
- Severe weather
- Sea level rise
- Ocean acidification
- Species extinction
- Human conflict

Responses:
- Mitigation: cut GHG
- Adaptation
- Geoengineering
Designing “CarFree” Cities to Welcome Millions Fleeing Rapid Sea Level Rise, Within a Few Decades

Bill Leighty, Director
The Leighty Foundation
Juneau, Alaska   USA
wleighty@earthlink.net
www.leightyfoundation.org/earth.php
907-586-1426       206-719-5554 cell
END 14 Nov 19 presentation at ASME – IMECE, Salt Lake City

Following slides are supplemental.
See more presentations, posters, videos at: www.leightyfoundation.org/earth.php
REFERENCES

  - “Carfree Cities” J.H. Crawford’s first book
- [http://carfreealliance.org/](http://carfreealliance.org/) (empty)
- [https://vimeo.com/146997345](https://vimeo.com/146997345) “Recovering from Disruption” video
- [https://vimeo.com/57560911](https://vimeo.com/57560911) “The Carfree District in Quebec City” video
- Climate Central [https://www.climatecentral.org/](https://www.climatecentral.org/)
- National Academies
- AAAS, Science Magazine
- MIT Technology Review, “Climate Issue”
This is a conceptual template for quickly installing high-density urbanization:

- Completely free of personal vehicles and their infrastructure
- As an integral loop -- donut, half-torus -- the only efficient topology for transit-only urbs
- "Helicopter down" upon low-density regions of extant cities, including brownfields
- Tangential and intersecting to accommodate more IDP's, and others attracted by CarFree lifestyle
- Population determines density and diameter: 100,000 or more, 3 km or more
- Long-term thinking guides and inspires short-term planning, to escape perpetual over-automobility
Rationale:

- Rapid sea level rise will be a global emergency: will humanity survive? Where and how?
- Rapid response to rapid sea level rise: we must accommodate millions fleeing low-lying coasts.
- "Taking" private property for CarFree loops will be justified, and must be compensated.
- Plan and invest now: mature this conceptual CarFree template.
- Design first for Accessibility; then for Mobility. Good urban design minimizes need for mobility.
- Transportation trends are now toward shared, driverless, electric; CarFree is the ultimate
- Optimizes Transportation As A Service (TAAS)
- Design for people, not for cars
- Design for minimum Earth impact, smallest human footprint, closed-cycle services
- Goals: conservation of land, energy, materials, residents' time
- Lower Cost Of Living (COL); improve health, reduce health care cost -- walk & interact more
- Safer for young people: walk and bike everywhere
Enabling design features:

- Contra-rotating, concentric, transit loops
- Fixed-guideway system (FGS) transit: Bus Rapid Transit (BRT), Light Rail Transit (LRT), streetcar
- Full-featured, community-center transit stations about every 500 m
- A train each way, every 5 min
- Integral, autonomous loop, donut, half-torus: the only transit-efficient design
- The FGS carries people, packages, freight, mail
- Continuous paving for all service vehicles, Transportation Network Companies (Uber, Lyft, et al)
- Peripheral parking lot(s) or structure(s) sequester the few for personal LDV’s, plus rental cars
- "Cars" are centrally sequestered, fueled, charged, guarded, always available
- Low public infrastructure capex, opex
- Reduce private capex, opex
All activities are within walking distance of a transit station, a community center serving two, contra-rotating, concentric, fixed-guideway transit systems carrying people, packages, mail, and freight -- the heart of each roughly symmetrical neighborhood, community -- a pearl on the necklace.

No highway-capable personal vehicles (cars, SUV's, vans, pickups), of any propulsion energy, are allowed in the urbanized area.

These morphable "Villages" -- design and purpose, style and theme architecture, and layout and density -- may vary greatly. With the integral "donut", the community can fit any situation, geography, topology, as overlaid on a real city: Density x Diameter determines Population.

See J.A. Crawford's CarFree City graphics, books, and videos at: www.carfree.com
1.5° C limit, or else … tipping?
- likely reach 1.5°C between 2030 and 2052 at current rate
- ~ 2050 achieve net-zero global anthropogenic CO₂

- DNV-GL “Energy Transition Outlook 2019”
  - Technology ready; policy not
  - Not fast enough
Notes - A:

1. J.W. Crawford, author: Joel Crawford <carfree@carfree.com> (edit @) www.carfree.com
   A large, eclectic website to explore. Two books may still be available:
   a. Carfree Cities
   b. Carfree Design Manual

2. Urgent: national, global emergency within a few decades. Sense of urgency, emergency absent. Disruption, collapse (Diamond)

3. Topologies, transportation systems

4. Health effects: walk more, improves health, reduce health care aggregate cost, pay for transport infrastructure as ROI

5. Accessibility, not mobility

6. Post WW2 mistake: design for cars, not for people; still propagating; stop digging hole deeper: Denver sprawl

7. IDP’s: how many, when. What are needs? Capabilities? Where put them?

8. Strategies: Avoid more sprawl
   Protect land; world’s best farmland
   Minimize embodied energy + operating energy
   Density(ies). HongKong? Singapore
   Carfree: need not own one; ops and presence not allowed
   Big savings in after-tax car ownership ~ $ 7,000 / yr
   TAAS, TNC’s, “3 revolutions” Sperling
   hydrogen: energy systems, trains, LRT, streetcar
   Build human community; encounters; commons

9. Design features: Proximity; access
   village, neighborhood, center, industrial park, cluster plan: Tokyo rail stations, other
   Jane Jacobs: eyes on the street
   safety, quiet
   “design with nature”, landscape architecture
   Flowchart, block diagram
Notes – B:

10. Goals:
   a. Physical health
   b. Mental health
   c. Happiness, well-being: epidemic of sadness
   d. Save health care cost; walk more; healthier people; pay for public amenities

11. Photos: Carfree cities, city centers

12. Costs: infrastructure capex
   • Public
   • Private

Costs: infrastructure opex
   • Public
   • Private