ENERG(sYstems)

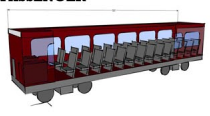
ZONE 1

TRAIN COMPONENTS

LOCOMOTIVE

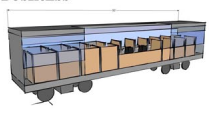
The primary locomotive for the passenger line will be a **Biogas Engine** fueled by methane generated from human waste at the Spokane Wastewater Treatment Plant (WWTP). During certain times of the year, both Diesel/Battery and Hydrogen Fuel Cell Locomotives may be used on the line.

PASSENGER



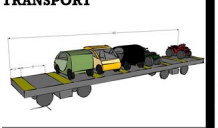
The passenger car will hold 56 passengers. There will be a central aisle for access, and at the front of the car will be an area for food and beverage preparation and service.

BUSINESS



The Business Car will house 20 cubicle seats for professionals working during the trip. All workstations will include wireless access and phone service. Passengers will have the option of a fully inclosed cubicle, a cubicle with a window, or a multi-seat conference cubicle.

TRANSPORT



The Transport Car will contain seven parking spaces for either small alternative fuel vehicles or ATVs. These vehicles will simultaneously with the passengers. Once secure, an attendant will plug the vehicle (if electric) into the train car to charge, while the passenger heads inside the train for the trip.

THE JOURNEY

At the inception of the project, the **Spokane-Pullman Passenger Rail** will consist of an engine and three cars. The train will carry up to 80 passengers in both the Passenger and Business Cars. There will be seven potential stops on the trip. These stops will be:

-Spokane, Spangle, Rosalia, Oakesdale, Garfield, Palouse, Pullman, and Moscow.

It is estimated that the trip will take approximately two hours from Spokane to Pullman.

While aboard the train, passengers will be able to perform work for their jobs in wireless "business" cars, as well as relax and eat in the passenger car.

Passengers with small alternative fuel cars or All Terrain Vehicles (ATVs) will be able to transport their vehicles with them for a slightly higher ticket price.

LOCOMOTIVE TYPES

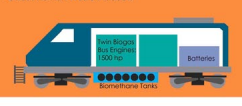
Passenger:

BIOGAS

A Bio-Methane locomotive will be the **primary engine** pulling the passenger train along the Spokane-Pullman line. It will refuel at the Spokane stop with bio-methane generated from the Spokane WWTP.

Bio-methane gas is delivered from the WWTP to the train, where the trains tanks are refilled. The gas is then let into the two engines that power the traction motors to drive the train.

SPECFICS:
-Carbon Neutral
-Abundant Renewable Energy Source (Human Waste)
-Utilizes Human Waste Products

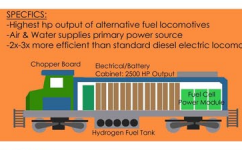


FUEL CELL/ELECTRIC

The Hydrogen Fuel Cell locomotive will be used as an alternative in the event that larger loads of people may need to be transported or more cars added for special events.

Hydrogen is used by an onboard fuel cell power module. The module produces electricity. The electricity from the batteries, or fuel cell, is throttled by the chopper board to power the traction motors.

SPECFICS:
-Highest hp output of alternative fuel locomotives
-Air & Water supplies primary power source
-2x-3x more efficient than standard diesel electric locomotive

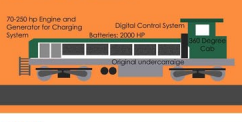


DIESEL/BATTERY

The Diesel Battery locomotive will be used for **light hauls** of passengers on the rail line, during the off-peak season. The locomotives will swap out batteries at specially designed stops in Spokane, Rosalia, and Pullman.

Modified from the Green Goat Switcher designed by Railpower Technologies, this locomotive uses a 200 hp diesel engine to keep the batteries at their optimum level of charge.

SPECFICS:
-Up to 2000 hp output
-Uses 40-60% less fuel
-Emits 80-90% less emissions
-Built from existing locomotives



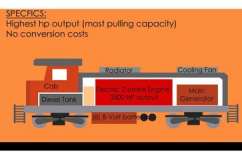
Freight:

DIESEL/ELECTRIC

Diesel electric hybrid locomotives will be utilized to maintain the requirement of pulling the thousands of tons of freight along the tracks.

Until the technology is developed to increase the power and efficiency of alternative energy locomotives, the diesel electric locomotive will remain the workhorse of the fleet.

SPECFICS:
Highest hp output (most pulling capacity)
No conversion costs



POWERING THE PALOUSE

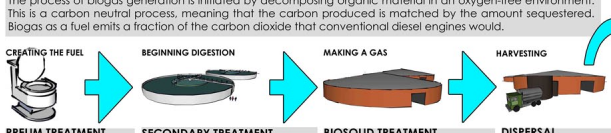
Faced with the crippling effect of Peak Oil, the threat of future energy shortages is a very real issue. Residents of the Palouse will need to embrace alternative forms of energy in order to create a sustainable system on which to survive.

This proposed energy system will revolutionize the way in which people, products, and ideas are transported throughout the Palouse, and the World.

By incorporating a hybridization of the best possible alternative energy systems for the region, as well as the transportation bond that connects them, citizens of the Palouse will be able to sustain their existence and continue as a major player in the Global Market.

BIOGAS SYSTEM a replacement for fossil fuels

The process of biogas generation is initiated by decomposing organic material in an oxygen-free environment. This is a carbon neutral process, meaning that the carbon produced is matched by the amount sequestered. Biogas as a fuel emits a fraction of the carbon dioxide that conventional diesel engines would.



PRELIM TREATMENT
STEP 1 – Human waste travels via Spokane's sewer system to the Wastewater Treatment plant.
STEP 2 – Screening begins to separate contaminants out of the waste.
STEP 3 – Primary settling of waste begins. Waste becomes sludge

SECONDARY TREATMENT
STEP 1 – Oxygen is introduced to activate microorganisms that begin to breakdown sludge and release gas.
STEP 2 – Sludge is transferred to the final settling basins. 5% of this is sent to the anaerobic digester, the remainder is sent back to continue aeration.
STEP 3 – The liquid component is recycled and re-treated for release.

BIOSOLID TREATMENT
STEP 1 – Sludge becomes concentrated.
STEP 2 – Thickened sludge is sent to the anaerobic digester.
STEP 3 – All oxygen is removed, sludge decomposes and produces biogas. Generated heat is returned for earlier treatments.
STEP 4 – Solid sludge is collected for use as a fertilizer.

DISPERSAL
STEP 1 – **Biogas** is compressed into storage tanks, to be collected by fuel trucks and transported to the railroad or bus depot.
STEP 2 – The **solid** sludge is gathered and delivered to agriculture farms, where the mix utilized as a fertilizer.

as a solid

AG. FERTILIZATION
Biowaste that could not be converted into a gas is recycled. The Aerobic digester is cleaned out and the sludge is used to spread over soil, fertilizing the land and providing for improved growing conditions.

1 of 3

Marie Allan
Derrick Eberle
Trevor Thompson

KEY
- PASSENGER RAIL LINE
- US-195
- WIND FARM
- SOLAR FARM
- GEOTHERMAL COMMUNITY
- TRAIN BATTERY SWAP
- ATVs ALLOWED
- ELECTRIC FILLING STATION
- BIOGAS FUELING STATION

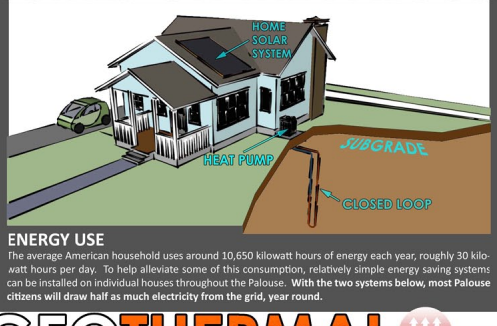
SCALE 0 1/4 1/2 1 Miles

SPOKANE WASTEWATER TREATMENT PLANT
GONZAGA UNIVERSITY
SPOKANE
WASHINGTON STATE UNIVERSITY
EASTERN WASHINGTON UNIVERSITY
SPANGLE

ENERG(sYstems)

ZONE 2

HOMES ON THE PALOUSE



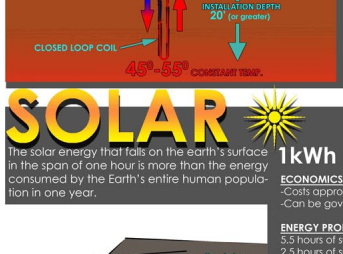
ENERGY USE

The average American household uses around 10,650 kilowatt hours of energy each year, roughly 30 kilowatt hours per day. To help alleviate some of this consumption, relatively simple energy saving systems can be installed on individual houses throughout the Palouse. **With the two systems below, most Palouse citizens will draw half as much electricity from the grid, year round.**

GEOTHERMAL

The U.S. Environmental Protection Agency has called ground-source heat pumps the most energy-efficient, environmentally clean, and cost-effective space conditioning systems available.

HEAT PUMP & CLOSED LOOP SYSTEM



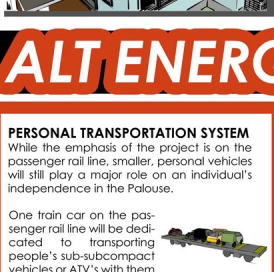
ECONOMICS
-Approximately **$12,500** for full install
-Cost returned through savings within 3–10 years
-Heat energy output greater than electricity input
-High capital costs, lower operation costs
-2x-5x cost of convential residential HVAC Install
-20-60% saving on utilities annually

LIFESPAN
-Longer life-span than convential HVAC systems
-20-50 years for the pump
-50-200 years for the loop field

SOLAR

The solar energy that falls on the earth's surface in the span of one hour is more than the energy consumed by the Earth's entire human population in one year.

1kWh HOME SOLAR SYSTEM



ECONOMICS
-Costs approx. $10,000
-Can be government subsidized

ENERGY PRODUCTION
5.5 hours of sunshine per day - 1,600 kilowatt hours/year
2.5 hours of sunshine per day - 750 kilowatt hours/year

LIFESPAN & WARRANTY
-System has a 5-year warranty
-Solar panels are warranted for 20 years

IMPACT
A 1-kilowatt home solar system will prevent approximately 170 lbs. of coal from being burned, 300 lbs of CO2 from being released into the atmosphere and 105 gallons of water from being consumed each month.

ALT ENERGY VEHICLES

PERSONAL TRANSPORTATION SYSTEM

While the emphasis of the project is on the passenger rail line, smaller, personal vehicles will still play a major role on an individual's independence in the Palouse.

One train car on the passenger rail line will be dedicated to transporting people's sub-subcompact vehicles or ATV's with them to their destination.

Alternative forms of energy will also power mass transit systems to help maintain a sustainable system.

ATV Renegade 800x

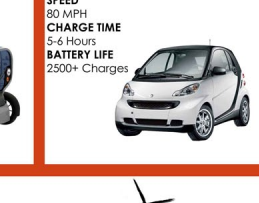
ATVs can be transported on the passenger train for a fee, and can be used in certain towns on the Palouse. They provide much less emissions than the standard automobile.

RANGE: 120 miles
COST $9,300 USD
SPEED 75-80 MPH
MPG 25-30 MPG

Biogas Bus

Powered 100% by bio-methane captured from human waste, these buses will be powered by the same type of engine in the passenger train's biogas locomotive. Though currently more expensive than fossil fuels, this carbon neutral system will be much better for the environment.

CAPACITY 60 people
SPEED 70 MPH



Venturi Eclectic Tribrid

This vehicle incorporates three types of energy to power the vehicle. A roof mounted solar panel, an onboard lithium battery, and a small wind turbine power the car for short trips.

RANGE:
Wind Breeze: 9 miles
Solar Panels: 4 miles
Lithium Battery: 30 miles
COST $33,000 USD
SPEED 30 MPH
CHARGE TIME 3 Hours Outlet 5 Hours Onboard
BATTERY LIFE 500+ Charges

SmartCar LiV Dash

This lithium powered rechargeable automobile is a two-seater that produces zero emissions.

RANGE: Lithium Batteries: 140 miles
COST $35,000 USD
SPEED 80 MPH
CHARGE TIME 5-6 Hours
BATTERY LIFE 2500+ Charges

2 of 3

SCALE 0 1/4 1/2 1 Miles

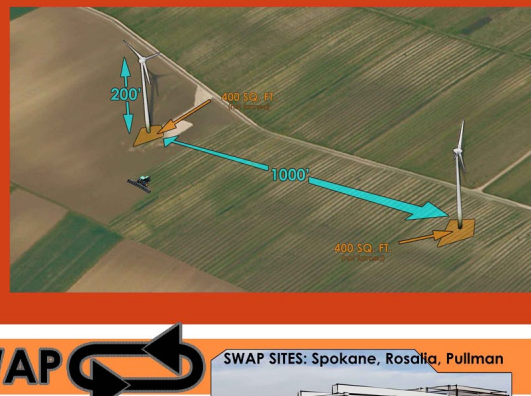
WIND

A feasibility study of the potential wind availability in the Palouse is currently underway near Rosalia and Oakesdale. Due to the realively small footprint of the turbines, wind systems and agricultural systems should be able to exist in harmony.

WIND REQUIREMENTS
- Utility Wind Turbines require a minimum of 13 mph of sustained wind to begin power generation
- For every 1 mph more, there is an increase of 33% more energy (ex. 12 mph generates 33% more energy than 11 mph)

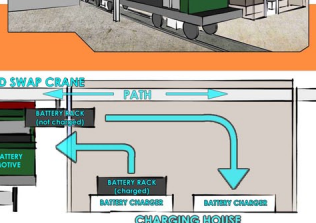
ENERGY PRODUCTION
-A Utility Turbine can generate about 16,000 kWh annually, more than enough to **power a typical household**.
-A larger, 1.8-MW turbine can produce more than 5.2 million kWh in a year, enough to power more than 500 households.

TAX CREDITS
- 12 cents per-kilowatt-hour production tax credit is granted in Washington State for use of wind power as an energy source.



THE BATTERY SWAP

SWAP SITES: Spokane, Rosalia, Pullman



DESIGNED FOR: DIESEL BATTERY LOCOMOTIVE

INTENT

The Diesel Battery locomotive is utilized at times when more trains need to be run on the Spokane-Pullman line, such as teh holiday season or during sporting events. This locomotive is a prime example of hybridization of energy systems in **Powering the Palouse**. To prevent dependency on one fuel source, this green locomotive wil be used as an alternative to Biogas.

Due to its lower horsepower, however, this locomotive will only pe used for light hauls, such as passengers. To maintain constant power throughout the trip, the batteries will be swapped out at specially altered sites along the rail line. This task will occur during passenger boarding.

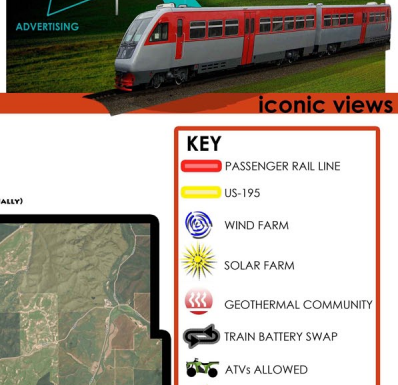
energy|advertisements

MAKING IT A REALITY

In order to make implementation of these systems a reality, big corporations will have the option to advertise throughout the rail line.

Whether on the train or amongst the backdrop of the Palouse, advertising will be incorporated in a tasteful and respective manner

By utilitzing techniques such as framing views with hollow billboards or carving logos into the rolling hills, corporations will help communities fund the new alternative energy infrastructure.



iconic views

ROSALIA

WIND FARM
1 MILE
1 MILE
-43 TUBINES
-220 MEGAWATT OUPTPUT (ANNUALLY)

OAKESDALE

WIND FARM
2 MILES
1 MILE
-86 TUBINES
-450 MEGAWATT OUPTPUT (ANNUALLY)

STEPTOE

GARFIELD

KEY
- PASSENGER RAIL LINE
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ENERG(sYstems)

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WIND FARM
1 MILE
1 MILE
-43 TUBINES
-220 MEGAWATT OUPTPUT (ANNUALLY)

PALOUSE

COLFAX

SOLAR FARM
1-2 MILE
1-2 MILE
1-2 MILE
-1 SQ. MILE TOTAL
-320 000 SOLAR PANELS
-64 MEGAWATT OUPUT (ANNUALLY)

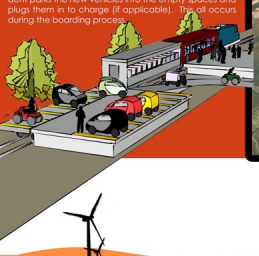
SOLAR FARM
1-2 MILE
1-2 MILE
-160 000 SOLAR PANELS
-32 MEGAWATT OUPUT (ANNUALLY)

VEHICLE TRANSFER

Passengers using the Spokane-Pullman Line will have the option of taking a small subcompact vehicle with them, such as an ATV or Smartcar, provided space is available.

To do this, passengers may purchase space for their vehicle upon purchase of their ticket. The idea behind this is to maintain personal independence.

To board, motorists will drive their vehicle up a ramp onto a platform adjacent to the track. There, an attendent will park the car. When the train pulls up, motorists on the train enter their car and drive off, while the attendent parks the new vehicles into the empty spaces and plugs them in to charge (if applicable). This all occurs during the boarding process.



MOSCOW

WASHINGTON STATE UNIVERSITY

UNIVERSITY OF IDAHO

PULLMAN

SCALE 0 1/4 1/2 1 Miles

3 of 3

TRAIN SCHEDULE TIMES | MON. - FRI.

MILES	SPOKANE TO MOSCOW	A.M./P.M. ARRIVE	A.M./P.M. DEPART
89	SPOKANE	A.M.	D - 9:00
70	SPANGLE	A.M.	A - 9:54 D - 9:59
55	ROSALIA	A.M.	A - 10:47 D - 10:52
44	OAKESDALE	A.M.	A - 11:16 D - 11:21
32	GARFIELD	A.M.	A - 11:47 D - 11:52
23	PALOUSE	A.M.	A - 12:18 D - 12:23
8	PULLMAN	A.M.	A - 12:50 D - 12:55
0	MOSCOW	A.M.	A - 1:40

TRAIN SCHEDULE TIMES | MON. - FRI.

MILES	MOSCOW TO SPOKANE	A.M./P.M. ARRIVE	A.M./P.M. DEPART
0	MOSCOW	P.M.	D - 3:00
8	PULLMAN	P.M.	A - 3:51 D - 3:56
23	PALOUSE	P.M.	A - 4:28 D - 4:33
32	GARFIELD	P.M.	A - 4:58 D - 5:03
44	OAKESDALE	P.M.	A - 5:29 D - 5:34
55	ROSALIA	P.M.	A - 5:58 D - 6:03
70	SPANGLE	P.M.	A - 6:32 D - 6:37
89	SPOKANE	P.M.	A - 7:27

REFERENCE NOTES:
- Stops containing city transit connections
- Stops containing zip car rental or boarding areas
- Stops containing ATV rental or recreation courses
- Stops containing bicycle rental, storage, and pathways
- All stops contain ADA access for passengers with disabilities in accordance with ADA regulations

TICKET RETURNS
Consult tickets for refund or credit claims to:
Train Reservations
Palouse Rail Line
P.O. Box 1122
Spokane, WA 99206

SAMPLE TRAIN SCHEDULE

PULLMAN TRANSPORTATION FARES

PASSENGER RAIL	$2 per 10 miles
+ VEHICLE TRANSPORT	$8
+ BUS	$1
+ ALT CAR	$15
+ ATV	$10
+ BICYCLE	$5
BUS (Available in: Spokane, Pullman, Moscow)	$2
ALT CAR (Available in: Spokane, Pullman, Moscow)	$15
ATV (Available in: Oakesdale, Rosalia, Garfield)	$10
BICYCLE (Available at All Stops)	$5

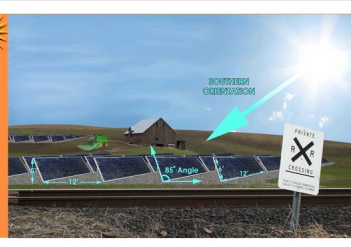
SAMPLE TRAIN RATES

SOLAR FARM

There are no fuel costs or emissions during the daily operations of solar plants. Relying on energy from the sun, which appears everyday, solar farms are the only alternative energy generators that are guaranteed to always produce energy (even on a cloudy day).

ENERGY PRODUCTION
-For every 10 acres, their is a potential to produce 1 Mw of electricity on a commercial scale
-5,000 Solar Panels are needed to produce 1 Mw of electricity

TAX CREDITS:
- 12 cents per-kilowatt-hour production tax credit for use of wind power as an energy source.



CAMPUS ENERGY DAY

Every year in April, students from Washington State University, Eastern Washington University, the University of Idaho, and Gonzaga University have a competition. They spend the day generating as much energy as they can in specially designed workout facilities.

Exercising on machines ranging from rowing to cycling to dance aerobics, students and staff have the opportunity to demonstrate school pride.

Aside from providing supplemental energy to the grid, this provides students with exercsie. In addition, this serves as a valuable learning experience that shows the upcoming generation a person's influence on our planet.