GSP KM SHARING 2019

หน่วยงาน: .....ทน.ทผก.....

เรื่อง: .....Hydrogen for fuel cell.....

GSP KM SHARING 2019 (วิสัยทัศน์ กลยุทธ์และนโยบาย)

GSP VISION

" To be World's Leading Gas Processing Business by 2020"

วิสัยทัศน์การจัดการความรู้

PTT Group Vision : Thai Premier Multinational Energy Company	**PTT GBU KM Vision:** บริหารจัดการองค์ความรู้ เพื่อสนับสนุนการดำเนินงานของธุรกิจก๊าซให้บรรลุตามกลยุทธ์ที่ตั้งเป้าหมายไว้อย่างยั่งยืน
PTT Group KM Vision : A World Class and Sustainable Learning Organization	**PTT GSP KM Vision:** เป็นขุมความรู้ในการบริหารธุรกิจแยกก๊าซฯให้เกิดประสิทธิภาพอย่างยั่งยืน

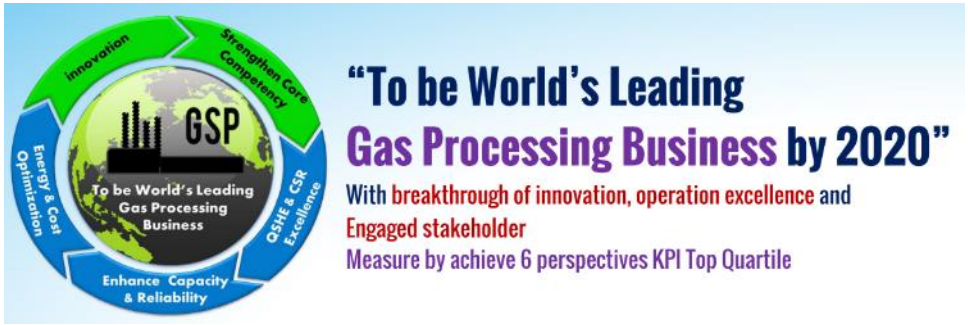
วิสัยทัศน์กลุ่มงาน :
Sustainable growth with innovation culture

GSP KM SHARING 2019 (วิสัยทัศน์ กลยุทธ์และนโยบาย)

GSP STRATEGIC DIRECTION & TOP QUARTILE TARGET 2017-2020

GSP KM SHARING 2019

(วิสัยทัศน์ กลยุทธ์และนโยบาย)



INNO ORGANIZATION

Production Planning & Technical Management Department

Mr.Supachai Laorrattanasak
Plant Technology & Innovation Division Manager

Plant Technology & Innovation Division

Process Technology

Mr.Perapong Lapasathukul

Miss Nutchanat Iyara

Mr.Chanwit Chansatirapanit

Digitization & Start up

Mr.Suragarn Klomkao

Miss Hathaichanok Rodrakhee

New member

Vision Team:
Sustainable Growth
with Innovation Culture

Innovation Theme

Process Technology

Project Development
3 topics

- LPG Aerosol Product
- U-Carbon Fertilizer Project
- Green Baking Soda Product

Feasibility for new S curve
2 topics

- H2 Fuel Cell Business
- Once Through Gas to Liquid (GTL)

Cost Saving
2 topics

- CO2 Membrane Test Skid at GSP6
- SCR Catalyst Business

New Business
2 topics

- ECO-CURE Water Treatment Skid
- Cold Energy Recovery Skid LNG Satellite

Digitization & Startup

Digitalization
3 topics

- AI-Sensor
- AI-Optimizer
- GSP Data Storage

New Product / Process Innovation
4 topics

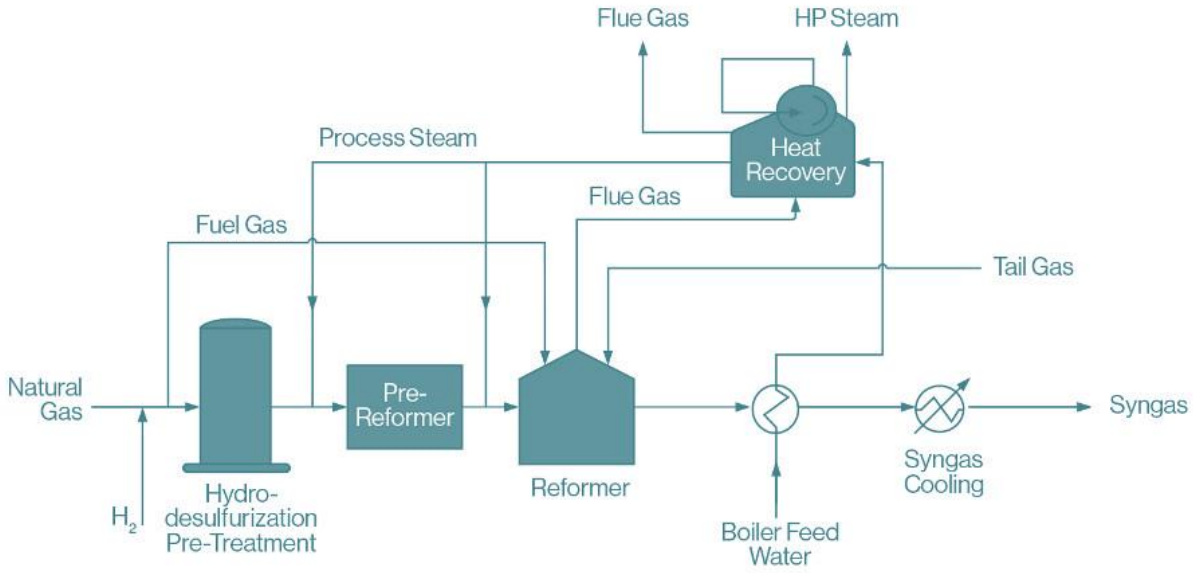
- Smart Log Sheet
- E-nose: Odor Emission Detection
- E-nose: LPG Aerosol Odor detector
- Amine Sampling Mug

Start up & Innovation System
3 topics

- Start Up Program
- Innovation Space
- GSP Innovation Culture

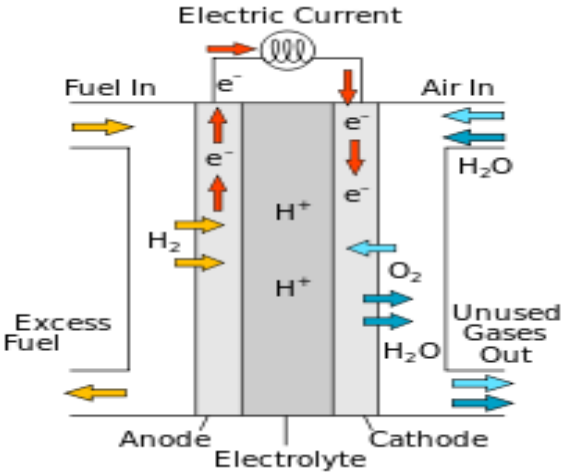
Hydrogen Fuel Cell Business

Steam Methane Reforming (SMR) technology for hydrogen production on both a small and large scale. SMR is a cost-effective and energy efficient way of producing hydrogen.

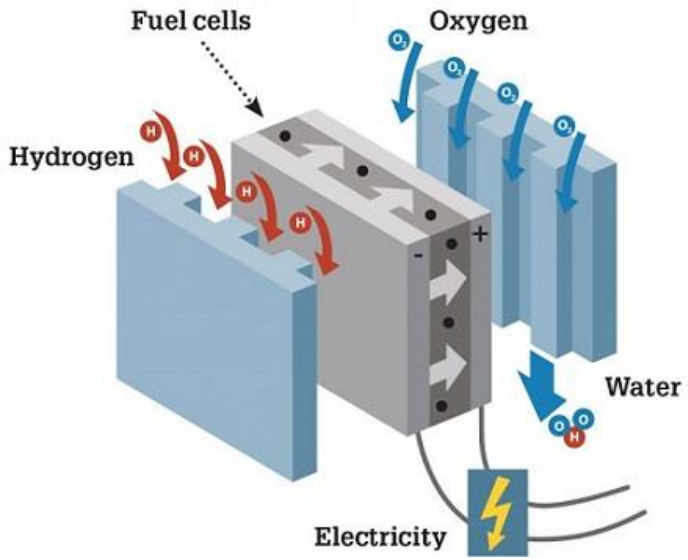


In the steam reforming process, a desulfurized hydrocarbon feedstock (natural gas, refinery off gas, liquefied petroleum gas or naphtha) is pre-heated, mixed with steam and optionally pre-reformed before passing a catalyst in a proprietary top-fired steam reformer to produce hydrogen, carbon monoxide (CO) and carbon dioxide (CO2). And the hydrogen is then separated using Pressure Swing Adsorption.

Fuel Cell Technology



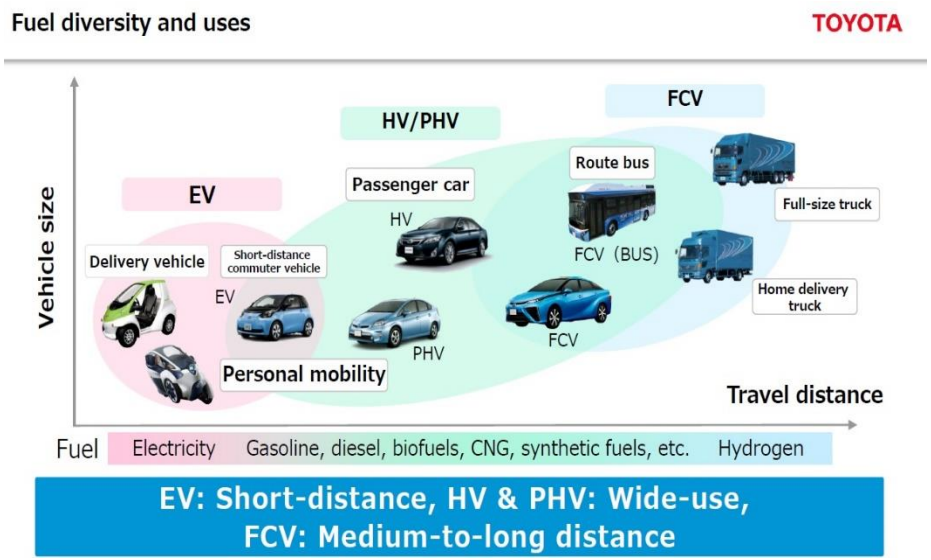
A fuel cell is a device that generates electricity by a chemical reaction. Every fuel cell has two electrodes, one positive and one negative, called, respectively, the anode and cathode. The reactions that produce electricity take place at the electrodes.



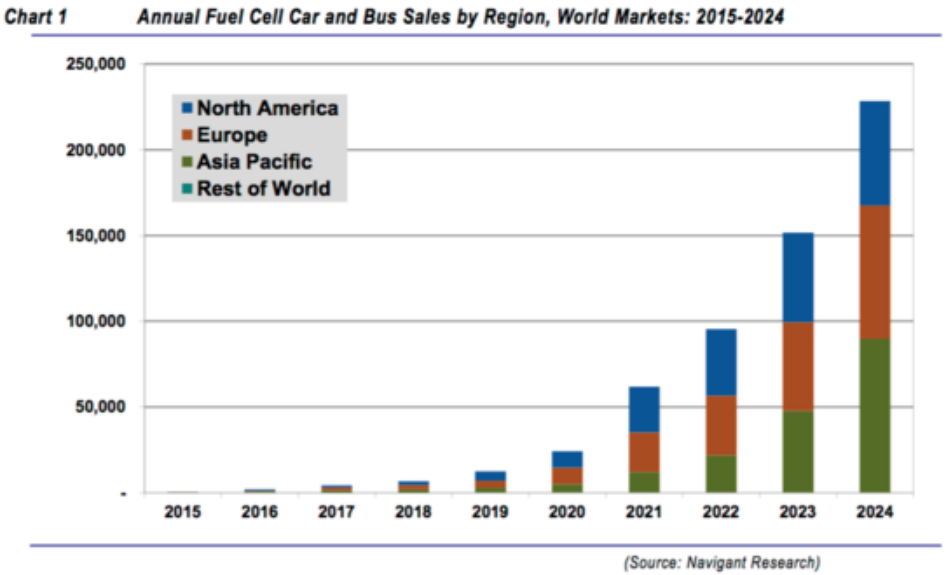
Hydrogen is the basic fuel, but fuel cells also require oxygen. One great appeal of fuel cells is that they generate electricity with very little pollution–much of the hydrogen and oxygen used in generating electricity ultimately combine to form a harmless byproduct, namely water.

Fuel Cell Technology

Fuel diversity and uses diagram by Toyota



Navigant Research forecasts that the annual sales of fuel cell vehicles (FCVs)—both cars and buses



Source:

https://www.greencarcongress.com/2015/12/20151202-navigant.html

https://insideevs.com/toyota-to-sell-30000-hydrogen-fuel-cell-cars-annually-by-2020/

World Trend Technology is changed, so we have to changed.
This is External Force Effect!!

Pro-Con

FCVs Technology	
Pro	**Con**
• Clean energy with high efficiency • **Fast refueling per long driving(3-5 mins for 450 km)** • H_2 can be made from renewable sources • Easily convert NGV station to supply H_2	• High investment • Need subsidized policy at beginning • Expensive to transport H_2

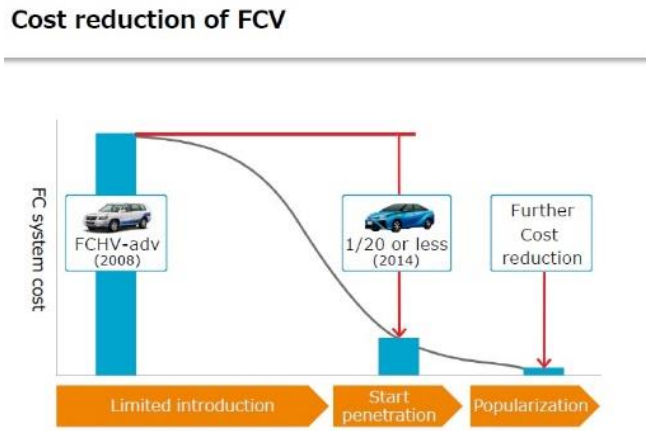
Fuel Cell Technology

Two key requirements for fuel cell larger-scale market introduction

- driving down vehicle costs to be competitive with battery and hybrid vehicle technology.

- developing the hydrogen infrastructure necessary to fuel the vehicles.

The key focus for PTT strength!



Project Opportunity

H_2 Refueling Station VS Existing NGV Network

Utilize existing facilities of NGV station and pipeline network

PTT has NGV stations network around Thailand 427 stations, which can utilize facilities of NGV station to Hydrogen station.

Hydrogen Production onsite (SMR)

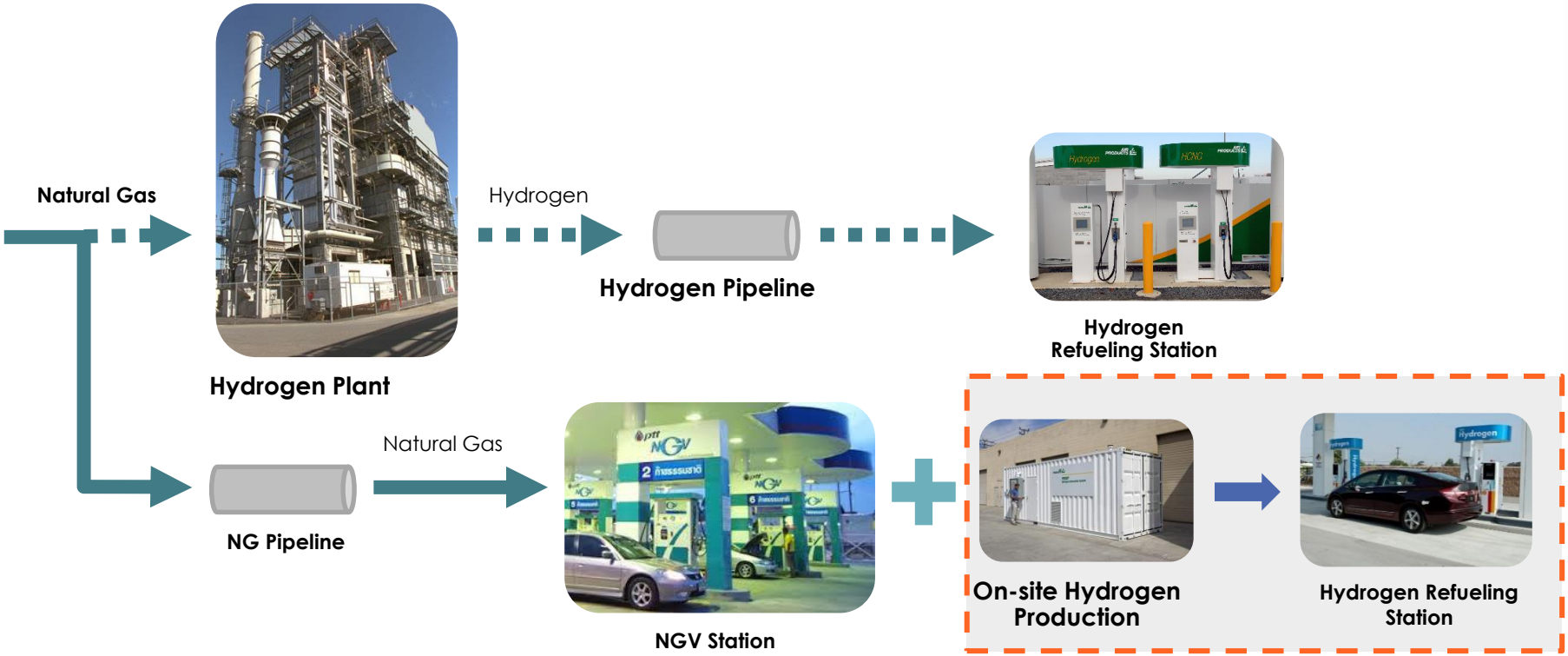
Hydrogen Refueling Station (HRS)

Hydrogen Production

Reaction:

Steam-methane reforming reaction: $CH_4 + H_2O \rightarrow CO + \mathbf{3H_2}$

Water-gas shift reaction: $CO + H_2O \rightarrow CO_2 + \mathbf{H_2}$



Hydrogen Production

Feed :
Natural Gas

Sulfur Removal

Reformer
- $CH_4 + H_2O \rightarrow CO + 3\ H_2$
- 700°C–1,000°C
- 3–25 bar

CO shift reactor
- $CO + H_2O \rightarrow CO_2 + H_2$

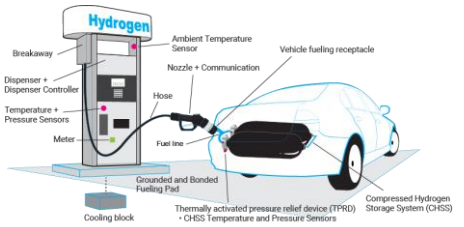
Methanation
- $CO + 3H_2 \rightarrow CH_4 + H_2O$

Dryer

PSA

Product :
Hydrogen 99.999%

CO < 0.2 ppm



95% of H2 produced in the United States is made by natural gas reforming

Project challenge

- Our target is NGV bus/truck

Basis of calculation		
Natural gas consumption	292,364.0	Nm3/h
NGV station in Thailand	400	Station
Natural gas consumption per station	730.9	Nm3/h
Fuel consumption of a Bus/Truck	40	kg/day
No of NGV Bus/Truck	46,514	units
assume 10% of NGV bus/truck reform t	4,651	units
H2 bus/truck per NGV station	12	units
Total H2 production per station	465.1	kg/day
H2 production rate	19.4	kg/h
	216	Nm3/h
H2 Production Capacity	250	Nm3/h

Project challenge

- Potential player of SMR technology onsite hydrogen production in market

AIR PRODUCTS

三菱化工機株式会社
MITSUBISHI KAKOKI KAISHA, LTD.

AIR LIQUIDE

MAHLER
ADVANCED GAS SYSTEMS

ZTEK
CORPORATION

THE LINDE GROUP
Linde

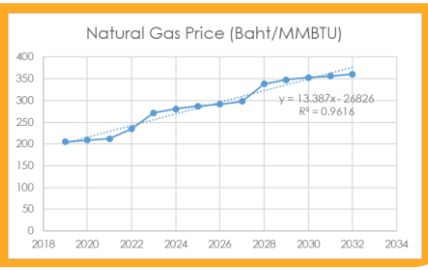
HYGEAR

Feasibility Study 2018: Hydrogen Production from Natural Gas

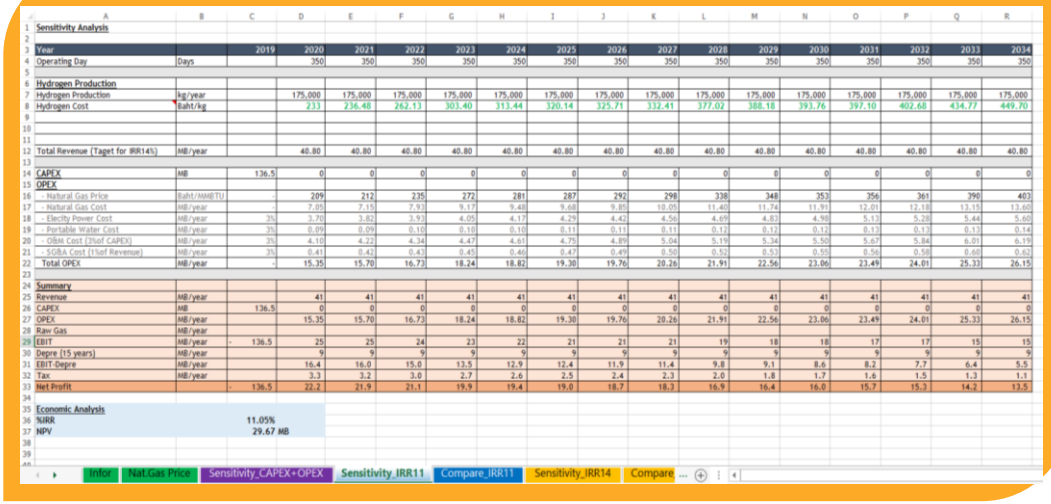
Prism H_2 Generators PHG250 Capacity of H2 Production = **500 kg/d**

Prism H_2 Generators PHG250

Natural Gas Price Forecast In 2019-2032



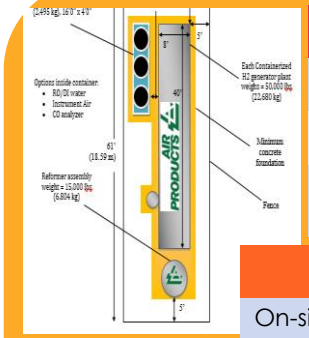
Feasibility Analysis



Sensitivity Analysis

Year		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Operating Day	Days		350	350	350	350	350	350	350	350	350	350	350	350	350	350	350
Hydrogen Production																	
Hydrogen Production	kg/year		175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000
Hydrogen Cost	Baht/kg		233	236.48	262.13	303.40	313.44	320.14	325.71	332.41	377.02	388.18	393.76	397.10	402.68	434.77	449.70
Total Revenue (Taget for IRR14%)	MB/year		40.80	40.80	40.80	40.80	40.80	40.80	40.80	40.80	40.80	40.80	40.80	40.80	40.80	40.80	40.80
CAPEX	MB	136.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OPEX																	
- Natural Gas Price	Baht/MMBTU		209	212	235	272	281	287	292	298	338	348	353	356	361	390	403
- Natural Gas Cost	MB/year		7.05	7.15	7.93	9.17	9.48	9.68	9.85	10.05	11.40	11.74	11.91	12.01	12.18	13.15	13.60
- Electy Power Cost	MB/year	3%	3.70	3.82	3.92	4.05	4.17	4.29	4.42	4.56	4.69	4.83	4.98	5.13	5.28	5.44	5.60
- Portable Water Cost	MB/year	3%	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.11	0.12	0.12	0.12	0.13	0.13	0.13	0.14
- OBM Cost (3%of CAPEX)	MB/year	3%	4.10	4.22	4.34	4.47	4.61	4.75	4.89	5.04	5.19	5.34	5.50	5.67	5.84	6.01	6.19
- SGBA Cost (1%of Revenue)	MB/year	3%	0.41	0.42	0.43	0.45	0.46	0.47	0.49	0.50	0.52	0.53	0.55	0.56	0.58	0.60	0.62
Total OPEX	MB/year	-	15.35	15.70	16.72	18.24	18.82	19.30	19.76	20.26	21.91	22.56	23.06	23.49	24.01	25.33	26.15
Summary																	
Revenue	MB/year		41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
CAPEX	MB	136.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OPEX	MB/year		15.35	15.70	16.72	18.24	18.82	19.30	19.76	20.26	21.91	22.56	23.06	23.49	24.01	25.33	26.15
Raw Gas	MB/year																
EBIT	MB/year	- 136.5	25	25	24	23	22	21	21	21	19	18	18	17	17	15	15
Depre (15 years)	MB/year		9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
EBIT-Depre	MB/year		16.4	16.0	15.0	13.5	12.9	12.4	11.9	11.4	9.8	9.1	8.6	8.2	7.7	6.4	5.5
Tax	MB/year		3.3	3.2	3.0	2.7	2.6	2.5	2.4	2.3	2.0	1.8	1.7	1.6	1.5	1.3	1.1
Net Profit		- 136.5	22.2	21.9	21.1	19.9	19.4	19.0	18.7	18.3	16.9	16.4	16.0	15.7	15.3	14.2	13.5
Economic Analysis																	
NJRR		11.05%															
NPV		29.67 MB															

Infor | Nat.Gas Price | Sensitivity_CAPEX+OPEX | Sensitivity_IRR11 | Compare_IRR11 | Sensitivity_IRR14 | Compare



NG/Utility	Quality
Natural Gas	3,650 scfh
Power	126 kw
Portable water	204 gph (0.72 m3/h)

H2 Production = **500 kg/d**

CAPEX	Amount
On-site installation	66.5 MB
Equipment	52.5 MB
Civil Work	17.5 MB
Total CAPEX	**136.5 MB**

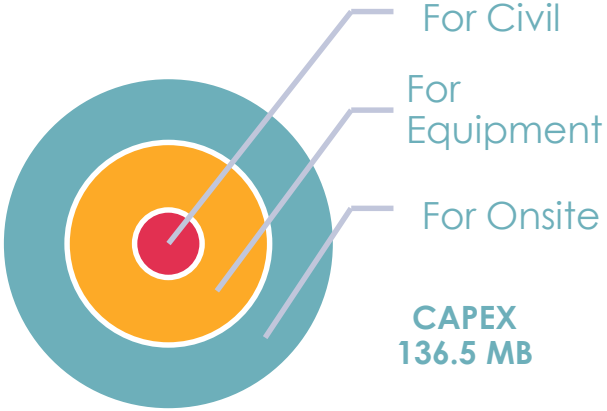
Economic Study

Project lifetime: 15 yrs
Tax: 20%
WACC: 11.05%

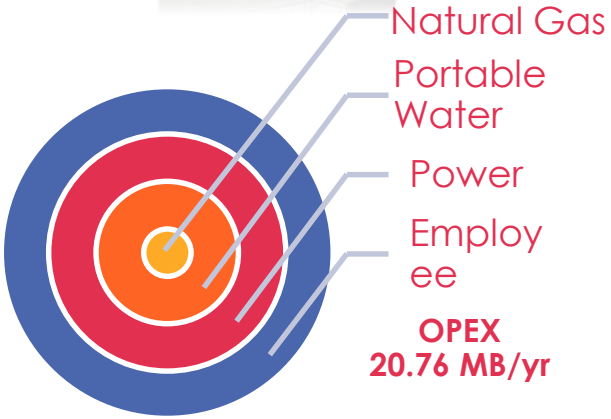
Therefore H2 Price = 345 Baht/kgH2

Feasibility Study 2018: Hydrogen Production from Natural Gas

Prism H_2 Generators PHG250 Capacity of H2 Production = **500 kg/d**



CAPEX
136.5 MB



OPEX
20.76 MB/yr

Economic Study

WACC: 11.05%

Therefore H2 Price = 345 Baht/kgH2

Economic Study

ICE
2.5 THB/km

Nissan Leaf

EV
0.8 THB/km

Toyora Mirai

FCV
3.7+ THB/km

TOYOTA MIRAI

Compare at distance 270 miles (432 km)

Source: https://www.standard.co.uk/lifestyle/motors/how-much-does-a-hydrogen-car-cost-to-run-a3595841.html

Roadmap Timeline

2018

Hydrogen Usage
Hydrogen production
Technology Study
Site visit in USA

2019

Deep technology selection
CAPEX and OPEX evaluation
Study potential forklift application in Thailand

2020

Forklift prototype application
Performance evaluation

2021

Project approval as stage-gate

Next..

Cross Functional Team

This project is the cooperation of GSP, InI and GBD team.

Knowledge sharing

- Innovation website

THANK YOU