Policy and Regulatory Environment for Development and Transfer of Renewable Energy Technologies

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Outline

- Introduction
- Key Consideration on Development and Transfer of Renewable Energy Technologies
- Thailand's Renewable Energy Policies and Regulatory Environment
- TISTR's Technology Readiness Level (TRL) to Support Renewable Energy Technology Transfer
- Conclusion

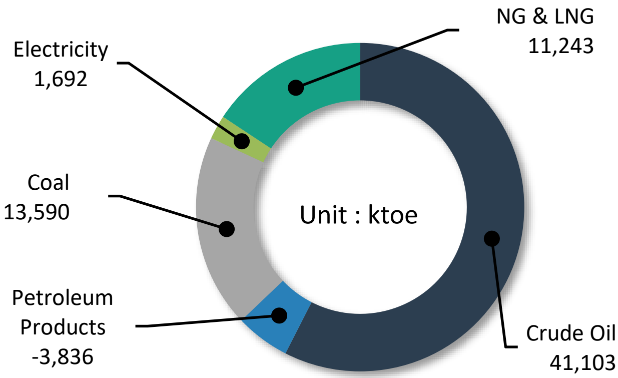
Role of Energy in SDGs

- SDG 7: (Affordable and Clean Energy) can be considered as an "enabling factor" for the achievement of other SDGs
- SDGs can not be achieved without the sustainable use of energy, particularly the increase share of renewable energy in the global energy mix

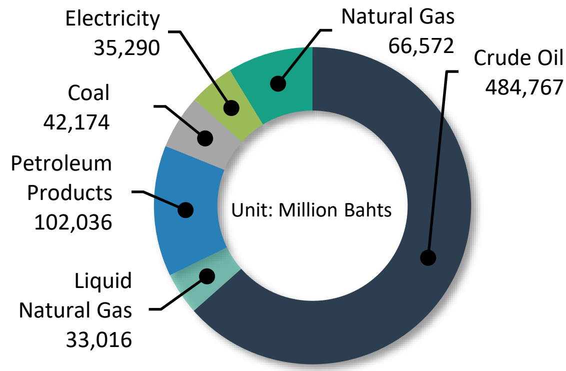
Thailand's Energy Import and Consumption in 2016

IMPORT

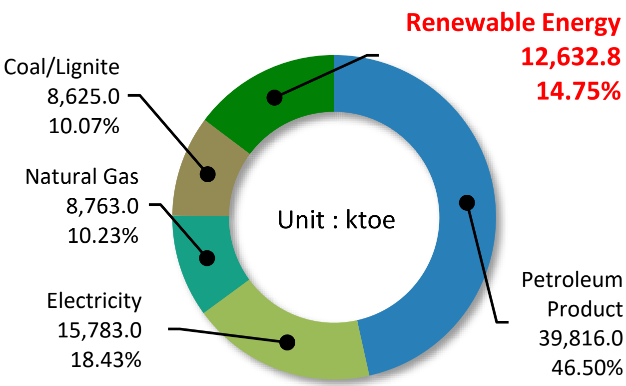
Total 63,792 ktoe



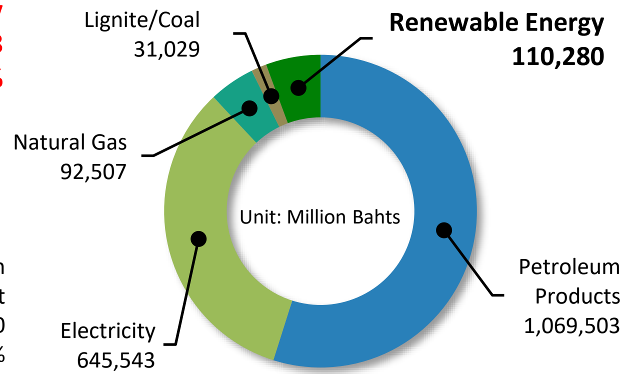
Total 763.9 Billion Bahts (5.32 % of GDP)



CONSUMPTION



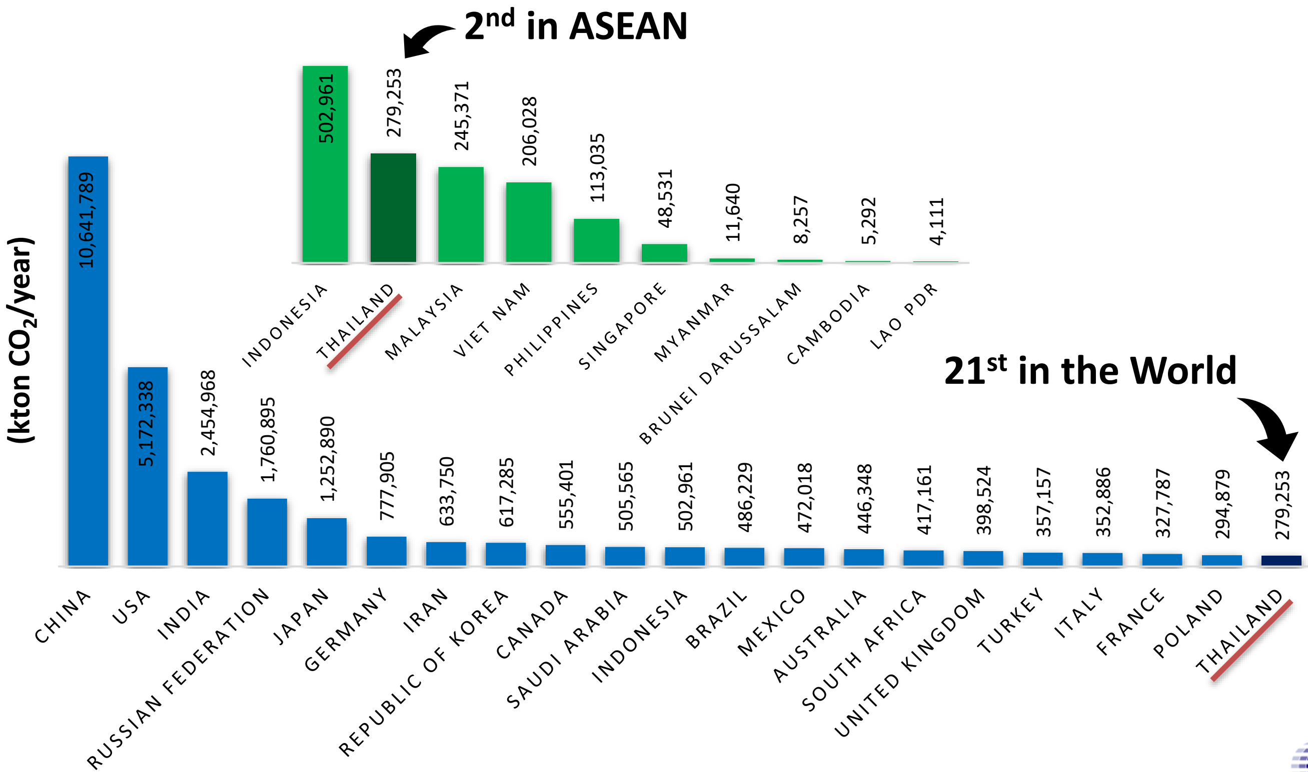
Total 85,620 ktoe



Total 1,948.9 Billion Bahts (13.56 % of GDP)

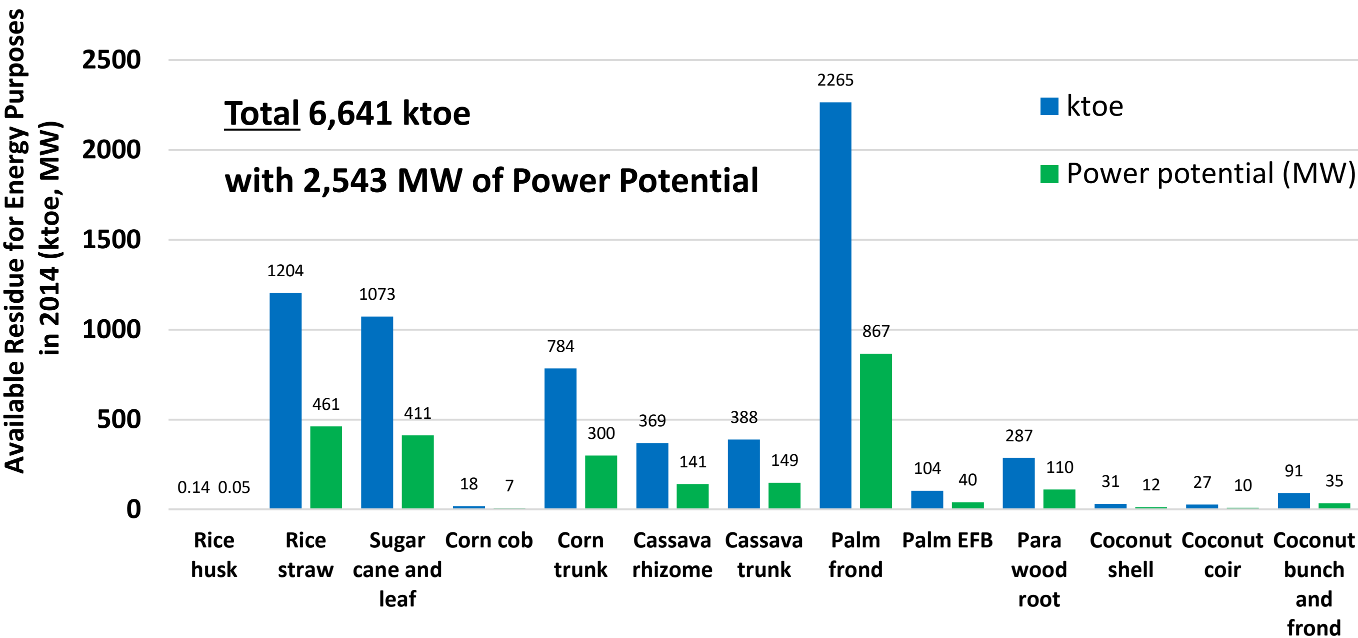
 Source: EPPO,2016

CO_2 Emissions of Fossil Fuel Use and Industrial Processes Emissions in 2015



Source: EDGAR, 2015

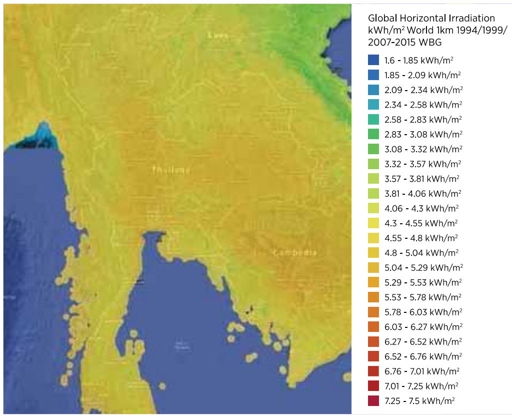
Biomass Residue Potential in Thailand

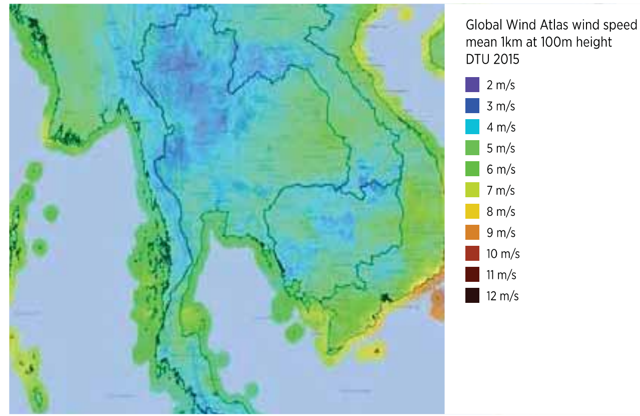


Rice | Sugar cane | Corn | Cassava | Palm oil tree | Para wood | Coconut

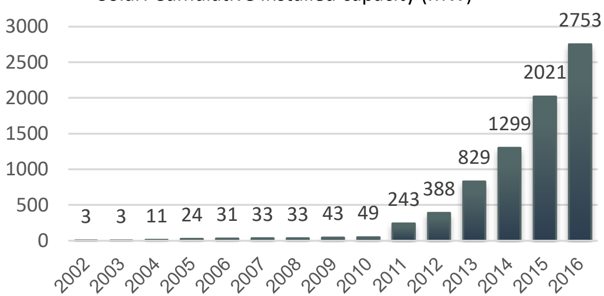
Source: DEDE, MOE

Solar and Wind Energy Resources Potential

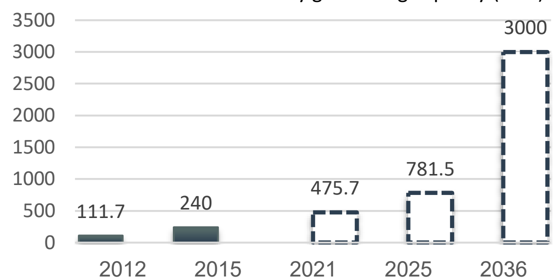




Solar: Cumulative Installed capacity (MW)



Wind: Total Installed electricity generating capacity (MW)



Source: Global Atlas for Renewable Energy (IRENA, 2017)

Renewable Energy Utilization

Source In 2016, Thailand	Electricity		Heat ktoe	Total ktoe
	MW	ktoe		
Solar Power	2,142	256	6	261
Wind Power	304	41	-	41
Small Hydropower	172	53	-	53
Waste to Energy	141	74	82	156
Solid Biomass	2,812	1,469	6,440	7,909
Biogas	408	213	592	805
Biofuels	Ethanol: 3.6 Million liters/Day (670 ktoe) Biodiesel: 3.8 Million lit/Day (1,183 ktoe)			1,853

Source: DEDE

Outline

Introduction

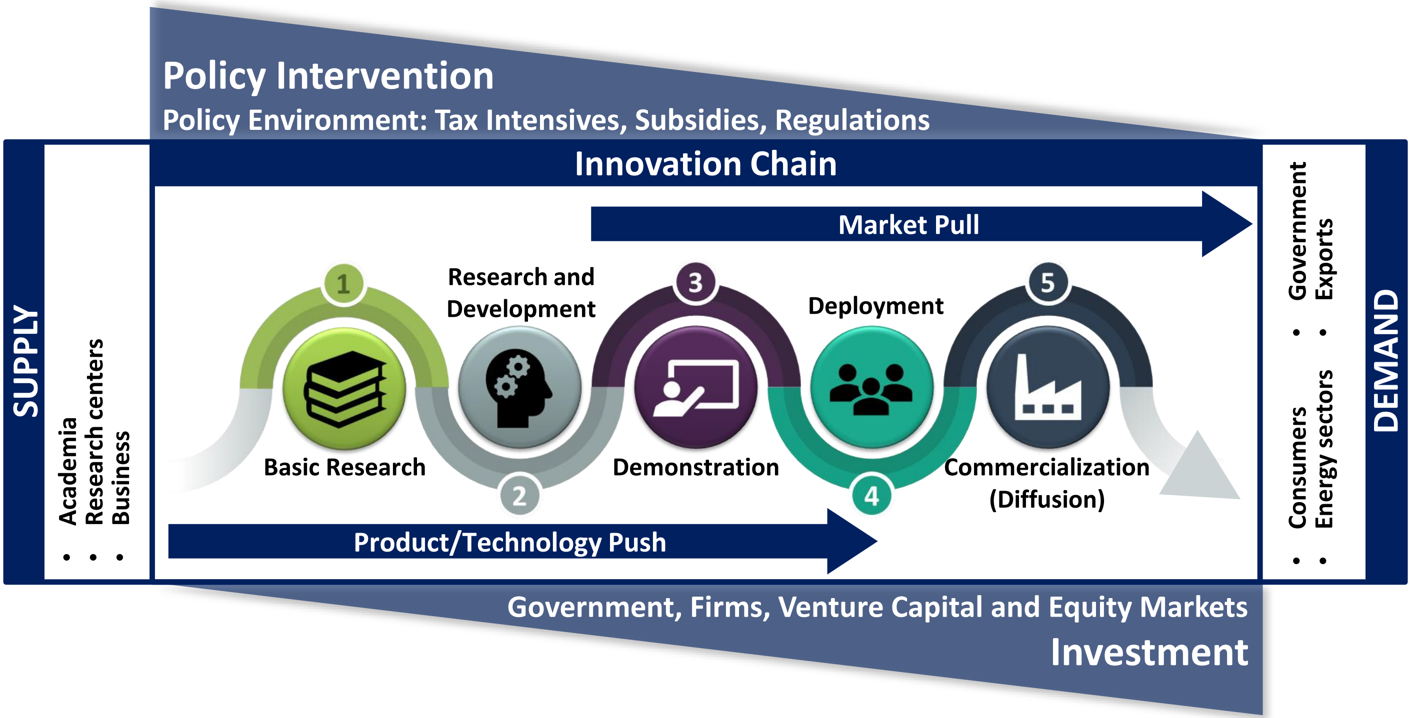
Key Consideration on Development and Transfer of Renewable Energy Technologies

Thailand’s Renewable Energy Policies and Regulatory Environment

TISTR’s Technology Readiness Level (TRL) to Support Renewable Energy Technology Transfer

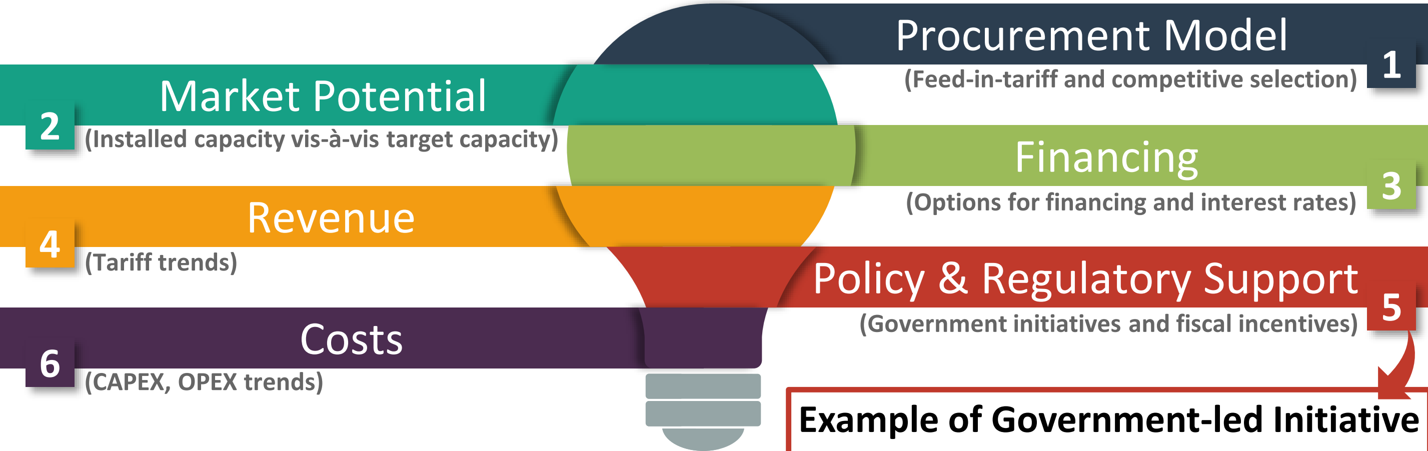
Conclusion

Innovation System for Development and Transfer of Renewable Energy Technologies



Source: Adapted from IEA 2008

Policy & Regulatory Support: Accelerator of the RE Ecosystem



Example of Government-led Initiative and Incentives to Promote RE

- **National RE targets**
  Ex . Most of the countries now have a target for 25-50% share of renewables in total energy mix.
- **Governments funds to support RE Projects**
  Ex . Such support can be in form of viability funding, credit guarantee facility or technical assistance.
- **Tax incentives**
  Ex . Exemptions or discounted from income tax.
- **Renewable purchase obligations**
  Ex . Large generators/utilities to mandatorily procure 5-10% of energy from RE sources.
- **Land availability**
  Ex . Government provides land for solar parks or exemption/reduction in land use fee for RE projects.
- **Research and development support**
  Ex . Government set-up Energy Research Institute to develop industry-oriented R&D.

Source: Adapted from the next frontier for infrastructure investments Renewable Energy in Asia-Pacific, PWC

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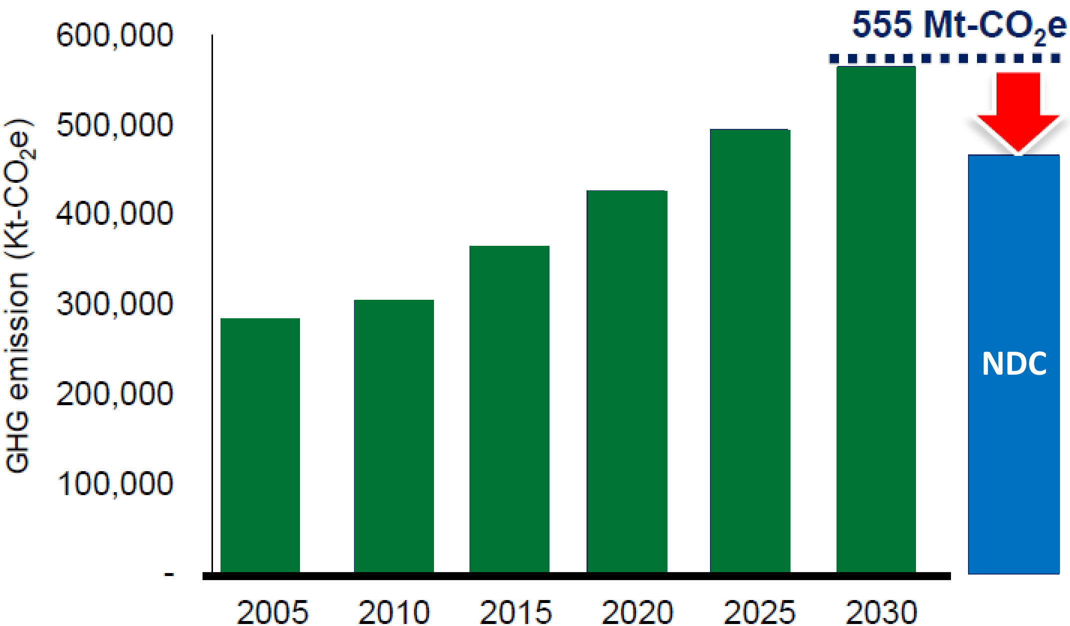
ASEAN Commitments to International Climate Policy

Country	Paris Agreement ratification	Emission reduction (unconditional)	Emission reduction (conditional)	Reference year	Target year
Brunei	21 Sep. 2016	Reduce energy consumption by 65%, increase share of renewables to 10%, reduce CO_2 emission in morning peak hour by 40%, increase total gazetted forest reserves 41-55%.		BAU	2035
Cambodia	6 Feb 2017	-	27%	BAU	2030
Indonesia	31 Oct 2016	29%	38%	BAU (2010)	2030
Lao PDR	7 Sep 2016	Activity-related target: increase forest cover 70%, increase share of renewable energy 30%		2000-2010	2015-2030
Malaysia	16 Nov 2016	35%	45%	Unit GDP (2005)	2030
Myanmar	19 Sep 2017	Implementation proposed without target set		-	2030
Philippines	23 Mar 2017	-	70%	BAU (2000)	2030
Singapore	21 Sep 2016	36%	-	2005	2030
Thailand	21 Sep 2016	20%	25%	BAU (2005)	2030
Vietnam	21 Nov 2016	8%	25%	BAU (2010)	2030
China	3 Sep 2016	60-65%		Unit GDP (2005)	2030
EU	5 Oct 2016	≥40%		1990	2030
USA	3 Sep 2016	26-28%		2005	2025

Thailand's Nationally Determined Target



20% Reduction at 2030 from BAU

up to 25% with support through global agreement under UNFCCC

Priority Sectors:

- Energy and Transport
- Waste
- Industrial Process and Product Use (IPPU)

Source: Climate Change Coordination and Management Division, Office of Natural Resources and Environmental Policy and Planning

Thailand NDC Roadmap on Mitigation (2021-2030)

Increase energy efficiency in households

Renewable energy in households

Renewable energy generation

Solid Waste Management

Industrial Wastewater Management

Increase power generation efficiency

Municipal Wastewater Management

Increase energy efficiency in transport

Clinker substitution

Promote biofuels

Replacement refrigerants

Increase energy efficiency in buildings

Renewable energy in industry

Increase industrial energy efficiency

Source : ONEP, 2017

Thailand Energy Master Plan

"Thailand Integrated Energy Blueprint (TIEB)"

Objectives

① Supply security
② Cost competitiveness
③ Environment
④ Energy support sustainability
⑤ Socio-economic support for the needed people/sector

PDP — **Power Development Plan**
- 20-25% cold fired power
- 15-20% renewable

EEP — **Energy Efficiency Plan**
- 30% energy intensity reduction

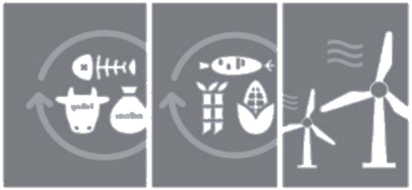
AEDP — **Alternative Energy Development Plan**
- Zoning and competitive bidding

GAS — **Gas Plan**
- Curb Gas demand (TBD)
- LNG structure

OIL — **Oil Plan**
- 20% of biofuel
- Fossil fuel subsidy removal

Source : DEDE, 2015

Alternative Energy Development Plan (2015-2036)



Increase Share of Renewables in Total Energy Consumption

30%
2036

Sector Breakdown

Power sector	Heating	Transport

Target of Renewable Energy Share

Power sector	Heating	Transport
20.11 % of Electricity	36.67 % of Heat	25.04 % of Transportation Fuel
1. MSW + Industrial Waste (550 MW) 2. Biomass (5,570 MW) 3. Biogas (1,280 MW) 4. Small Hydro (376 MW) 5. Wind (3,002 MW) 6. Solar (6,000 MW) 7. Large Hydro (2,906 MW)	1. MSW + Industrial Waste (495 ktoe) 2. Biomass (22,100 ktoe) 3. Biogas (1,283 ktoe) 4. Solar Heat (1,200 ktoe) 5. New-Energy (Geothermal, Used Tire Oil, etc) (10 ktoe)	1. Biodiesel (14 ML/Day) 2. Ethanol (11.3 ML/Day) 3. Pyrolysis Oil (0.53 ML/Day) 4. CBG (4,800 t/Day) 5. Alt. Fuels (10 ktoe)

Source: DEDE, 2015

Ethanol Action Plan

Ethanol usage (MLPD)

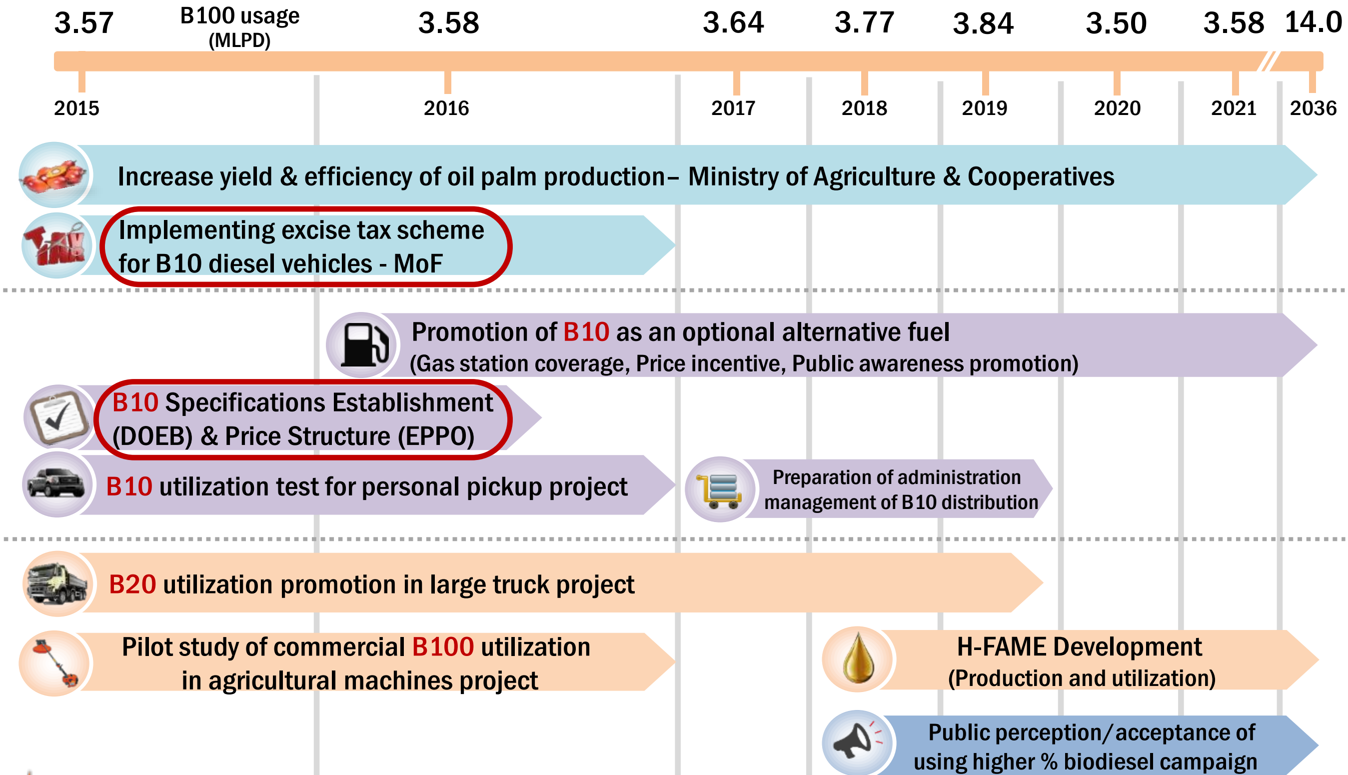
2015	2016	2017	2018	2019	2020	2021	2036
3.30	3.55	3.84	4.11	4.27	4.42	4.79	11.30

- Increase yield & efficiency of sugarcane/cassava production – Ministry of Agriculture & Cooperatives
- Reconstruct gasohol E20 and E85 price structure & mechanisms to be more incentive (by EPPO)
- Increase E20 and E85 gas station coverage (to be in accordance with car numbers) (by DOEB)
- Renewable Energy Act
- Improvement of ethanol yield from cassava and cassava chips project
- Biofuel utilization for transport sector project
- 2nd-generation ethanol production development project
- Biofuel utilization promotion project (Finish Mar-2016)
- E20 & E85 public awareness and acceptance promotion campaign
- Promotion of E20 & E85 utilization on government and state enterprise vehicles

Department of Alternative Energy Development and Efficiency
MINISTRY OF ENERGY

TISTR

Biodiesel Action Plan



Department of Alternative Energy Development and Efficiency
MINISTRY OF ENERGY

Regulatory Environment

"Regulatory frameworks include wide range of support instruments to support the RE policy implementation"

Financial Incentive

- Several financial incentives have been introduced as policy mechanism to accelerate RE's investment

- **Feed-in-Tariffs (FITs)**
    - A minimum guaranteed price for electricity generated from RE sources
    - A premium on market price for delivery to the grid
    - Long term contracts, high degree of certainty for RE producers/Investors

Feed-in-Tariff for Renewable Energy for Very Small Power Producer, VSPPs (Commercial Operation Date: COD 2017)

(1 € = 40 THB)	FiT(F) THB/kWh	FiT (V2017) THB/kWh	Total calculated FiT THB/kWh	Period of support Years	FiT Premium For Bio-Energy (8 years) THB/kWh	FiT Premium Southern Provinces[2] (project lifetime) THB/kWh
1. Industrial Waste						
Existing WTE plants[1]	2.39	2.69	5.08	20	0.70	0.50
New WTE plants	2.39	2.69	6.08	20	0.70	0.50
New WTE plants using plasma technology	2.39	2.69	6.08	20	1.70	0.50
2. Municipal Solid Waste, MSW (e.g. incineration, gasification)						
Capacity ≤ 1 MW	3.13	3.21	6.34	20	0.70	0.50
Capacity > 1-3MW	2.61	3.21	5.82	20	0.70	0.50
Capacity > 3 MW	2.39	2.69	5.08	20	0.70	0.50
3. Waste (landfill gas)	5.60	-	5.60	10	-	0.50
4. Biomass						
Capacity ≤ 1MW	3.13	2.21	5.34	20	0.50	0.50
Capacity > 1 to 3MW	2.61	2.21	4.82	20	0.40	0.50
Capacity > 3MW	2.39	1.85	4.24	20	0.30	0.50
5. Biogas (from wastewater / waste products)						
	3.76	-	3.76	20	0.50	0.50
6. Biogas (from energy crops)						
	2.79	2.55	5.34	20	0.50	0.50
7. Hydro power						
Capacity ≤ 200 kW	4.90	-	4.90	20	-	0.50
8. Wind power	6.06	-	6.06	20	-	0.50

[1] Waste-to-energy power plants that are operational before 16 February 2015

[2] Including the provinces of Yala, Pattani, Narathiwat and 4 districts in Songkla province (i.e. Chana, Thepa, Saba Yoi and Na Thawi)

Source: Derived from NEPC Resolution 15th December 2015 and NEPC Resolution 16th February 2016

Regulatory Environment (cont.)

Financial Incentive

Tax Incentives

- Tax credits, tax reduction, tax exemption
- Introduce to increase competitiveness of RE

Government Funds to Support RE Project

- Support in the form of viability funding, credit guarantee facility or technical assistance
- Energy Service Company (ESCO) funds
- Thailand Board of Investment (BoI) funds

THAILAND BOARD OF INVESTMENT

 Source: The next frontier for infrastructure investments Renewable Energy in Asia-Pacific, PWC

Example of Renewable Energy Projects Supported by the Thailand Board of Investment (BoI)

Energy Plans	Approved by 2015		Approved by 2016	
	No. of Power Plants	Capacity (MW)	No. of Power Plants	Capacity (MW)
Waste (MSW and non-hazardous industrial waste)	18	228	4	165
Biomass	196	2793	8	125
Biogas	196	585	8	15
Solar farm	239	1422	62	256
Solar rooftop	153	83	9	76
Wind	36	1916	1	10
Waste heat	7	172	1	12
Total	845	7199	93	661

Source: Renewable Energy Outlook Thailand, IRENA 2017

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TISTR Algal Excellent Center

Functional Ingredients

PTTEP

Malee

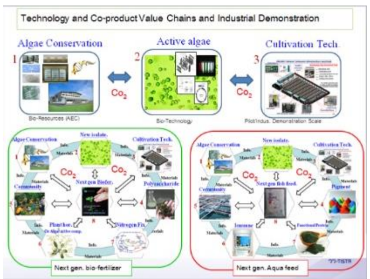
Algae Oil Production

ptt DENSO

Algaesoft Daily Set

Algae Cultivation Technologies

TRL 1-3 → TRL 4-5 → TRL 6 → TRL 7 → TRL 8 → TRL 9



Next Gen. Agri. Technologies

PTTEP ptt

Co_2 Utilization Technologies

Siam Nostoc and Microalgae Ltd.

Algae Ball

Patthamaka Ltd.

Bio-fertilizer

TRL Status : Completed by TISTR | Being Co-developing with Other organization/Company | Licensed

Bio-Methanol Production from Biogas Technology

Laboratory Scale: Autothermal

Reforming Reactor, 0.025 L/day

RPS

CRYOTECH

TRL 1-2 → TRL 3-4 → TRL 5-6 → TRL 7 → TRL 8-9

- Technology Concept

The Prototype of Bio-Methanol Synthesis from Biogas in Semi-Pilot Scale : 1 L/day

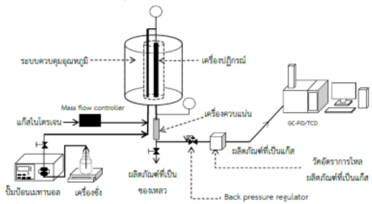
Demonstration Plant of Bio-Methanol: 10,000 L/day

TRL Status : Completed by TISTR | Being Co-developing with Other organization/Company | Future work

TISTR

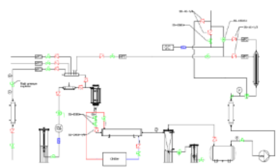
Bio-methanol to Hydrocarbon Technology

Laboratory Scale: Bio-methanol to Gasoline and High Value Chemical Co-products (BTEX), 0.01 L/day



TRL 1-2 | TRL 3-4 | TRL 5-6 | TRL 7-9

- Technology Concept



Semi-Pilot Scale: Bio-methanol to Gasoline and High Value Chemical Co-products Technology, 0.5 L/day

TRL Status : Completed by TISTR (blue) | Future Work (grey)

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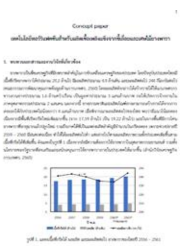
Solid Biofuel Production by Torrefaction Process

Laboratory Scale: Preliminary Result on Solid Biofuel Production from Para-rubber Wood by Torrefaction Technology

Prototype of Solid Biofuel Production from Para-rubber Wood by Torrefaction Process

TRL 1-2 → TRL 3 → TRL 4-5 → TRL 6 → TRL 7-9

- Technology Concept



- Optimum Condition for Solid Biofuel Production from Para-rubber Wood by Torrefaction Process in Laboratory Scale
- Design of Prototype of Solid Biofuel Production from Para-rubber Wood by Torrefaction Process

TRL Status : Completed by TISTR | Future Work

Gasification Technology

- Demonstration Plant: 3 Stages Gasification Process with Tar Reduction Technology + Gas Engine
- Torrefied Biomass Pellet Production System: 40 ton/ day.

TRL 1-2 → TRL 3-5 → TRL 6 → TRL 7-8 → TRL 9

Demonstration Plant: 3 Stages Gasification with Gas Engine for Electricity Generation: 250 kW, 7.5 ton biomass/day

Commercial Scale Plant in which 90% of Technology Made in Thailand including Drawing , Operating and Maintaining Documents.

TRL Status : Completed by TISTR | Being Co-developing with Other organization/Company | Future work

Biogas Technology for Electricity

Multi feedstocks Biogas Pilot Plant for Electricity Generation
250 kW capacity,
10 ton biomass/day

Wastewater Treatment with Membrane Bioreactor Technology for Leachate and Organic Waste.

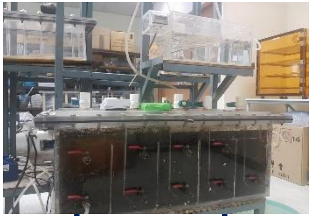
TRL 1-5 | TRL 6 | TRL 7-8 | TRL 9

- R&D on Biogas Technology in Laboratory Scale
- Biogas Pilot Plant Design

Commercial Scale Plant in which 90% of Technology Made in Thailand including Drawing , Operating and Maintaining Documents.

TRL Status : Completed by TISTR | Being Co-developing with Other organization/Company | Future work

Biogas for Wastewater Treatment Technology



Semi-Pilot Scale

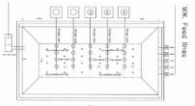
TRL 1-3 | TRL 4 | TRL 5 | TRL 6-7 | TRL 8 | TRL 9

Concept Technology

Laboratory Scale

P.S.CH. GROUP

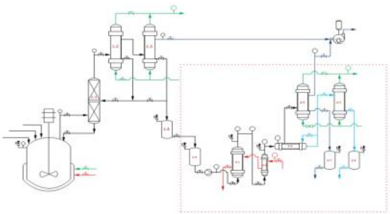
Demonstration
11,000 m^2



TRL Status :	Completed by TISTR	Being Co-developing with Other organization/Company	Future work

Cellulosic Ethanol Production Technology

Process Simulation



Semi- Pilot Scale Cellulosic EtOH 99.95%, 10 L/Day

TRL 1-3 → TRL 4 → TRL 5 → TRL 6-7 → TRL 8 → TRL 9

Laboratory Scale

TRL Status : Completed by TISTR | Being Co-developing with Other organization/Company | Future work

Ethanol Dehydration Technology

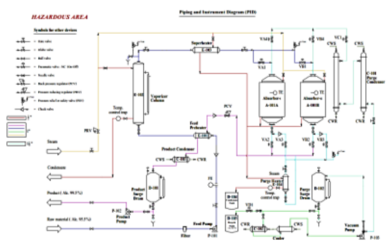
Semi - Pilot Scale
1.5 L/Day

องค์การสุรา กรมสรรพสามิต
Liquor Distillery Organization

Commercial Scale
1500 L/Day

TRL 1-3 → ~~TRL 4~~ → TRL 5-7 → TRL 8 → TRL 9

Demonstration Plant PID



Demonstration Plant
500 L/Day

TRL Status : Completed by TISTR | Being Co-developing with Other organization/Company | Future work

The Production of the 3A Molecular Sieve from Cellulosic Ethanol Production Waste for Anhydrous Ethanol Process

TRL 1

☑ Literature Review

- The dewatering of aliphatic alcohols using 3A and 4A zeolite molecular sieves and their regeneration, in the TSA process, are effective. TSA cycles comprising of dewatering and regeneration stages for three water-alcohol systems that are the ethanol, n-propanol, and n-butanol. (Elzbieta Gabrus, et. al., 2013)
- The paper study the adsorption characteristics of zeolites which using zeolites as adsorbents for the dehydration of ethanol. The result confirmed that a zeolite having a framework structure with a small Si/Al ratio and exchanged with a monovalent cation species showed the strongest affinity to water in ethanol. (Takuji Yamamoto et. al., 2012)
- The synthetic of Zeolite NaA using sugar cane bagasseas silica source under hydrothermal condition at 80 °C for 72–160 h. The synthesized material has a potential application as a catalyst, as adsorbent, and as an ion exchanger. (Murilo Pereira Moises, et. al., 2013)

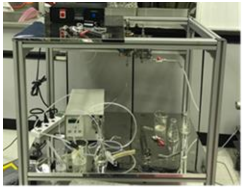

Chemical Engineering Journal

Experimental studies on 3A and 4A zeolite molecular sieves regeneration in TSA process: Aliphatic alcohols dewatering–water desorption

TRL 2

☑ Applications

The 3A molecular sieve product was used for anhydrous ethanol process.



TRL 3

☑ Experiment

Bagasse Ash

↓

Study the suitable condition such as Ash:KOH ratio and time

↓

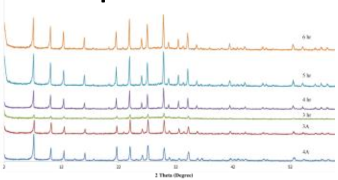
Study the physical and chemical propertiies

↓

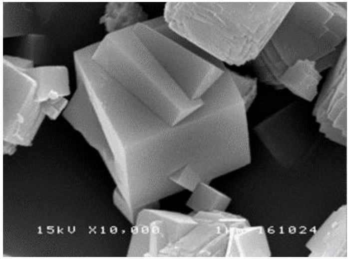
Study the water ads orption capacity

TRL 4

☑ Experiment Result



XRD pattern of the 3A Molecular Sieve Ratio 1:3 at 550 °C



Scanning Electron Microscope (SEM) images of 3A Molecular Sieve activated at 550 °C for 5 hr.

TRL Status : Completed by TISTR | Being Co-developing with Other organization/Company | Fut ork

Hydrogenation of Fatty Acid Methyl Ether (H-FAME)

AIST NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

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สวทช NSTDA

Lab Scale: 0.3 L/Batch

Pilot Scale

100 L/Batch

H-FAME an Alternative Upgraded Biodiesel

TRL 1-3 → TRL 4 → TRL 5 → TRL 6-7 → TRL 8 → TRL 9

TRL Status :	Completed by TISTR	Being Co-developing with Other organization/Company	Future work

The Research Development for Environment Management Sustainable for Plastic Waste in Community

TRL 1 | **TRL 2** | **TRL 3-7** | **TRL 8-9**

☑ Literature Review

- The comprehensive overview of the state of the art in the field of automated sorting of source-separated MSW for the purpose of recycling. (Sathish Paulraj Gundupalli et.al, 2017)
- Applying coagulation–flocculation with iron trichloride removed the non-biodegradable organic matter in the leachate from the Central Landfill of Asturias (Spain) (L. Castrill et.al, 2010).
- Seperation of NIR-HIS online classification of waste plastics. The NIR-HIS can identified of six groups of plastics ABS, PS, PP, PE, PET, and PVC. (Yan Zheng, et.al, 2018)
- The lower biogas production costs can be achieved with an integrated solid waste management system whose decentralized solid state anaerobic digestion system. (Chukwunonso Chinedu Anyaoku, et.al, 2018)
- Production of high quality RDF requires a multiple-stage waste treatment and separation process. (R. Sarc, et.al, 2013)

☑ Applications

Green Technology for Waste Management

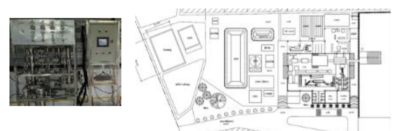
- Semi-Automation Sorting (Odor Removal with Ozone and Natural Molecular Sieve Technology)
- Near Infrared and Vision System (NIR)
- Waste water treatment and reused by SBR and Smart Bio-Coagulant
- Compost / Effective Microorganism (EM)
- Biogas via Anaerobic Baffled Reactor (ABR)
- Compressed Biomethane Gas (CBG)
- Refuse Derived Fuel (RDF)
- Flake Process

☑ Challenge

Circular Economy Concept

☑ Prototype and Experiment

☑ Pilot Plant Design



Green Technology for Waste Management

Training

Green Innovation Community Based Solid Waste Management: Green InnoCBM

☑ Pilot Plant and Demonstration plant

☑ Operational use of deliverable

Transfer technology and knowledge to Subdistrict Administration Organization (TanDaew, Saraburi)

TRL Status : Completed by TISTR | Being Co-developing with Other organization/Company | Future work

Research and Development for Landfill Reclamation and Value Added Product from Municipal Waste

TRL 1 | **TRL 2** | **TRL 3-5** | **TRL 6-9**

☑ Literature Review

- The recycling potential of old open dumpsites by using landfill mining. The bi-soil in geo-environmental application is used to evaluate the compatibility of the residual matrix for the disposal in temporary storages. It was mainly focused on the presence of heavy metals and on the possible interaction with test organisms. (S. Masi. et.al , 2014)
- Leachate from urban solid waste landfills is a mixture of organic and inorganic substances that cause damage to the environment, due to the high concentration of recalcitrant organic matter and toxicity. The Fenton process (especially solar photo-Fenton), was efficient in increasing the biodegradability and reducing the toxicity of the leachate. (Fabio Moraes da Costa a et al., 2018)
- Applying coagulation–flocculation with iron trichloride or with aluminium polychloride removed the non-biodegradable organic matter in the leachate from the Central Landfill of Asturias (Spain) (L. Castrill et.al, 2010).
- Application of wood plastic composites (WPCs) obtained from recycled materials initially intended for landfill is usually limited by their composition. (Juliana S. et al, 2013)


Waste Management

Fenton treatment of landfill leachate under different COD loading factors

☑ Applications

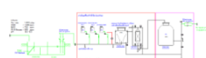
- Prototype of mobile bioremediation batch for natural water sources contaminated from municipal waste dumping sites
- Prototype for landfill leachate and waste water treatment by coagulation via fenton and sludge utilization
- Beneficial product from land fill reactivation
- Composite material from plastic landfill waste.

☑ Challenge

Water Treatment

BOD > COD | **COD > BOD**

Prototype of Mobile Bioremediation batch



Prototype for Landfill Leachate Treatment by Coagulation via Fenton

Landfill PVC Plastic → Composite Material

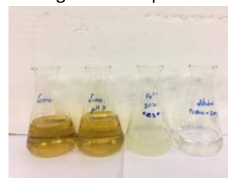
Sludge

Sludge → Beneficial Product

Plant + Heavy Metal

☑ Experiment

Design for all experiments



COD removal > 85%
Color removal > 98%
Total Dissolved Solid (TDS) removal > 40%

Output

- Prototype of mobile bioremediation batch for natural water sources contaminated from municipal waste dumping sites
- Prototype for landfill leachate and waste water treatment by coagulation via fenton and sludge utilization
- Beneficial product from land fill reactivation
- Composite material from plastic landfill waste.

Transfer Technology and Knowledge to Pilot Plant in Saraburi Province

TRL Status : Completed by TISTR | Being Co-developing with Other organization/Company | Future work

Environmental Friendly Products from Palm Oil Industries

TRL 1 | TRL 2 | TRL 3 | TRL 4-7

☑ Literature Review

- Sphagnum farming refers to the cultivation of Sphagnum mosses to produce Sphagnum by using ingredients in growing substrates, as material for peatland. (Rémy Pouliot et al., 2015)
- Research for biochar production from hydrothermal carbonization. (Novianti et al., 2015)
- Research and development for coagulant properties for various commercial coagulant (Aluminum, Ferric and Silicate) in poly aluminum ferric silicate (Jack Lin et al.,2016)
- Preparation for inorganic coagulant from ash. (Tong Sun et al., 2011)
- Research in bio soil conditioner from organic precursor. (Rachinee, 2015)

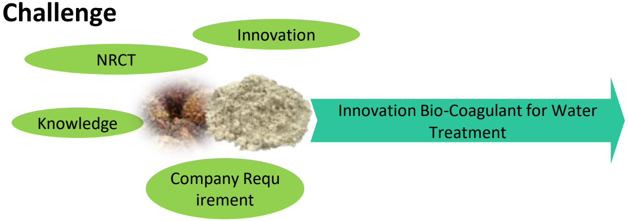

Ammonia Removal from Giant Fresh Water Prawn Farm by using Zeolite from Oil Palm Ash

☑ Applications

For application

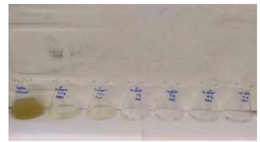
- Bio-containers made from palm bunch for preventing root-rot diseases
- Growing media development from palm oil industry for substitution of peat moss
- Solid fuel production from palm empty fruit bunch via hydrothermal carbonization process
- Development of clear water product from palm ash for water treatment
- Soil amelioration composite materials from empty fruit bunches

☑ Challenge



☑ Experiment

Design for all experiments



The results for color removal from customer (Thai Namrung Co., Ltd.)

Output

1. Bio-containers made from palm bunch for preventing root-rot diseases.
2. Technology for growing media from palm oil industry for substitution of peat moss.
3. Prototype for solid fuel production from palm empty fruit bunch via hydrothermal carbonization process.
4. Technology for clear water product from palm ash for water treatment soil amelioration composite materials.
5. Soil amelioration composite materials from empty fruit bunches

TRL Status : Completed by TISTR | Being Co-developing with Other organization/Company | Future work

TISTR

Business Model Canvas (BMC) : Biomethanol

Competitors
- Imported methanol from China (100%)

Key Partners
- RPS company Ltd.
- Cryotech Company Ltd.
- Universities
- Catalyst suppliers
- (+ 1 more company- under the process of discussion)

Key Activities
- Design, construction, commissioning, operation biomethanol pilot/demonstration plant
- Catalyst development

Key Resources
- Expert researchers with experience in running biomethanol production pilot plant
- Expert researchers and engineers in energy, chemistry and materials
- Physical infrastructure
  - Biogas / bio-chemical pilot plant and demonstration plant
- IP

Value Propositions
- Product: "Cost-effective biomethanol production technology"
- Trash-to-cash
- Eco-product for Clean Development Mechanism (CDM) and CO_2 mitigation (National NDCS, Paris Agreement)
- Waste Utilization via bioenergy (biogas, biofuels) and biochemical (methanol and other valuable biochemical products)
- Product diversification from wastes

Customer Relationships
- Demonstration plant
- Reference sites
- Co-invest

Marketing and Communication Channels
- Focus group meetings
- VDO-clip (media)
- BOI Fair
- International Expo
- VC meeting

Customer Segments
- Company with biogas producing from wastewater treatment plant
- Biodiesel production plant
- Clean coal power plant

Trends
- NDCs
- GHG mitigation
- Eco-industry
- Low carbon society

Costs
- Catalyst development
- Process development (gas separation / purification / chemical reactions system)
- Employee wages

Revenue Streams
- Licensing
- Royalty fees
- NDA disclosure fee
- Co-invest

Outline

- Introduction
- Key Consideration on Development and Transfer of Renewable Energy Technologies
- Thailand's Renewable Energy Policies and Regulatory Environment
- TISTR's Technology Readiness Level (TRL) to Support Renewable Energy Technology Transfer
- **Conclusion**

Conclusion

- The development of renewable energy in Thailand has been increased progressively.
- Policy and Regulatory Environment is one of the key roles for making the development and transfer of renewable energy technologies more practical and manageable.
- It is a necessity for driving renewable energy technology towards commercial viability by encouraging deployment and reducing investor risk via suitable IP management.

Thank you