1A1 Public Electricity and Heat Production

GHG mitigation options	Management / System	Energy efficiency	Fuel switching	Heat & Power recovery
Target (CO2 reduction)	Improve load factor and smoothen load shape	Maximize efficiency with cleaner technology		
Drivers	Market-driven, Need to optimize electricity demand and supply, Growing of Variable-RE	Environmental concern and saving of primary energy		
Capacity gap and barrier	Difficulty of changing power development planning concept, Technology Import reliance, High investment need	Problem on social acceptance High cost, Low efficiency, often maintenance, remote fuel source Problem on social acceptance, unclear national position and HRD , Concern on waste management	High cost and unclear business model, lack of infrastructure of hydroen supply	Limit market for only industrial application
Technology options and Research questions	**Smart grid** **Long-term** - Smart system for Distributed generation (DG), energy storage ad RE integration - Micro-grid and Nano-grid development **Short-term** - CEMS, HEMS, BEMS, FEMS - Technology for real-time pricing - ICT integration - Intelligent charging system **Current** - FEMS is partly introduced, BEMS is in illustration. - Centralized generation **Research questions** - How to enhance efficiency and reliability of overall system (G-T-D) + improve load shape - How to enhance RE market integration - How smart system we need / Which system is fitted to our need (DG, Minigrid and etc. **Energy storage (utility scale)** **Long-term** Litium-based battery, Fly wheel, Super conductor, Hydrogen storage **Short-term** Compressed Air Energy Storage (CAES), Sodium Sulfer (NaS) Battery **Current** Pump storage hydro **Research questions** - How to reduce cost, enhance capacity, improve time response	**Coal-fired power plant** **Long-term** - Advanced Ultra-Supercritical (A-USC) - Integrated Gasification Combined Cycle (IGCC) - Integrated gasification fuel cell (IGFC) - Carbon Capture and Storage (CCS) **Short-term** - Supercritical (SC) - Ultra-supercritical (USC) - Circulating fluidised bed combustion (CFBC) **Current** - Subcritical Pulverized Combustion **Research questions** - How to improve the efficiency and reduce GHG and non-GHG emissions of the existing and new plants - How to minimise generation from older, inefficient plants - How to reduce cost differential against PC combustion - How to communicate and engage **NG power plant** **Long-term** - Gas Turbine hybrid system **Short-term** - Advanced Humid Air Turbine (AHAT) - Advanced cooling, combustion and heat insulation **Current** - Combined Cycle Gas Turbine (CCGT) - Open-cycle gas turbine (OCGT) **Research questions** - How to raise efficiency and reduce emissions - How to reduce high capital cost differential against Open-cycle gas turbine	**Nuclear power plant** **Long-term** - Small modular reactors (SMRs) - Pressurised heavy water reactors (PHWRs) - Gas-cooled reactors (GCRs) - Generation III/IV reactors, e.g. fast bleeder **Short-term** - Boiling water reactors (BWRs) - Pressurised water reactors (PWRs) **Current** - No nuclear power plant but have plan placed on PDP2015 **Research questions** - How to improve, reliability, economic competitiveness, proliferation resistance and physical protection - How to improve overall safety and operational performance - How to improve waste management by reducing longterm radiotoxicity of the ultimate waste - How to improve constructability, reduce costs and shorten construction spans - How to enhance public awareness of **Fuel cell** **Long-term** - Solid oxide fuel cells (SOFC). - Molten carbonate fuel cell (MCFC) **Short-term** - Proton exchange membrane fuel cell (PEMFC) - Alkaline fuel cell (AFC) - Phosphoric acid fuel cell (PAFC) **Current** - Polymer-Electrolyte Fuel Cell (PEFC) **Research questions** - What is new high performance material - How to increase technical lifetime and system efficiencies - How to reduce investment cost - Increase operational flexibility by improving ramp-up rates, start times	**CHP** **Long-term** - Low-temp waste-heat recovery - Fuel cells CHP **Short-term** - Micro CHP - Reciprocating engine CHP - Trigeneration or polygeneration **Current** - Topping/bottom Cycle CHP - Gas and steam turbine CHP **Research questions** - Which system is cost-effectiveness - How to maximize energy efficiency, optimize fuel flexibility, and minimize waste streams - How to find advanced thermoelectric Materials for Efficient Waste Heat
Current technology support	**Smart energy and energy storage:** - NSTDA: R&D activities on energy storage - EGAT: R&D activities and project developement for smart grid and energy storage - MEA & PEA: R&D activities - Pilot project of RE and Smart grid: Palouy Island (DEDE), Pattaya (PEA), Mea-Hong-Sorn (EGAT) - University: CU, อ. วัฒนพงษ์ (PU, NU)	**Coal-fired and NG power plant:** - EGAT: R&D activities and project developement for coal and NG power plant - University: CU, KMUTT, KMUTNB	**NPP:** - EGAT: R&D activities and project developement - University: CU	**Fuel cell:** - NSTDA: R&D activities on Fuel cell - EGAT: (R&D and project developement for fuel cell) - University: KMUTT/JGSEE, PSU	**CHP:** - EGAT: R&D activities and project developement for CHP
Resources	**Policy and Regulation:** - Restructure power industries and planning methodologies corresponding to smart grid and the growing of RE market (e.g. Integrated Resource Planning, Distributed generation) - Identify key components of potentially domestic production for each technologies and provide privilaeges, e.g. tax incentives, BOI and etc for domestic firms with in-house R&D to build up the demand of innovative products.	**Institution:** - Set up centers of excellences for government agencies and research universities in each single technology, and linkage with the utilities and power producer businesses, e.g. Outcome Delivery Unit (ODU). - Establish independent agency, to certify standard of smart grid devices including on-and-off grid RE technologies.	**Financial support:** - Cluster national R&D budget and funding according to priorities - Encourage R&D agencies to apply for international funding - Establish low carbon funds and develop mechanism of in-and-out flow principle, e.g. carbon tax collection to support R&D of clean technologies.	**Capacity building:** - Strengthen international relations and research network to enhance R&D activities, e.g. training, exchange programes, research projects and etc at all level. - Developce accessible database for experts, publications, patents and intellectual properties.
References	**Smart grid, Energy storage** EPPO/ERI - Smart grid roadmap (2014) STI - TNA report (2012) MTEC - Energy Storage (Presented by Dr. Pimpa 2016) IRENA - RE and Storage roadmap (2015) IEA - Technology Roadmap for Energy Storage (2014)	**Coal, Gas, Nuclear, CHP** TRF/KMUTT - Roadmap for Clean Coal Technology TRF/EGAT/CU-ENG - NPP roadmap for Thailand IEA - High-Efficiency, Low-Emissions Coal-Fired Power Generation CURC/EPRI - Advanced Coal Technology Roadmap METI - Technology Development Roadmap IEA - Nuclear Energy GIF - A Technology Roadmap for Generation IV Nuclear Energy Systems	**Fuel cell and CHP** IEA - Hydrogen and Fuel Cells METI - Technology Development Roadmap U.S. DOE - National CHP Roadmap U.S. DOE - Combined Heat and Power: A Decade of Progress, A Vision for the Future U.S. DOE - Combined Heat and Power: A Clean Energy Solution BPA - Energy Efficiency Technology Roadmap	