FRENCH-THAI ELECTRICITY FORUM
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An Electrical Infrastructure for Sustainable Development in THAILAND

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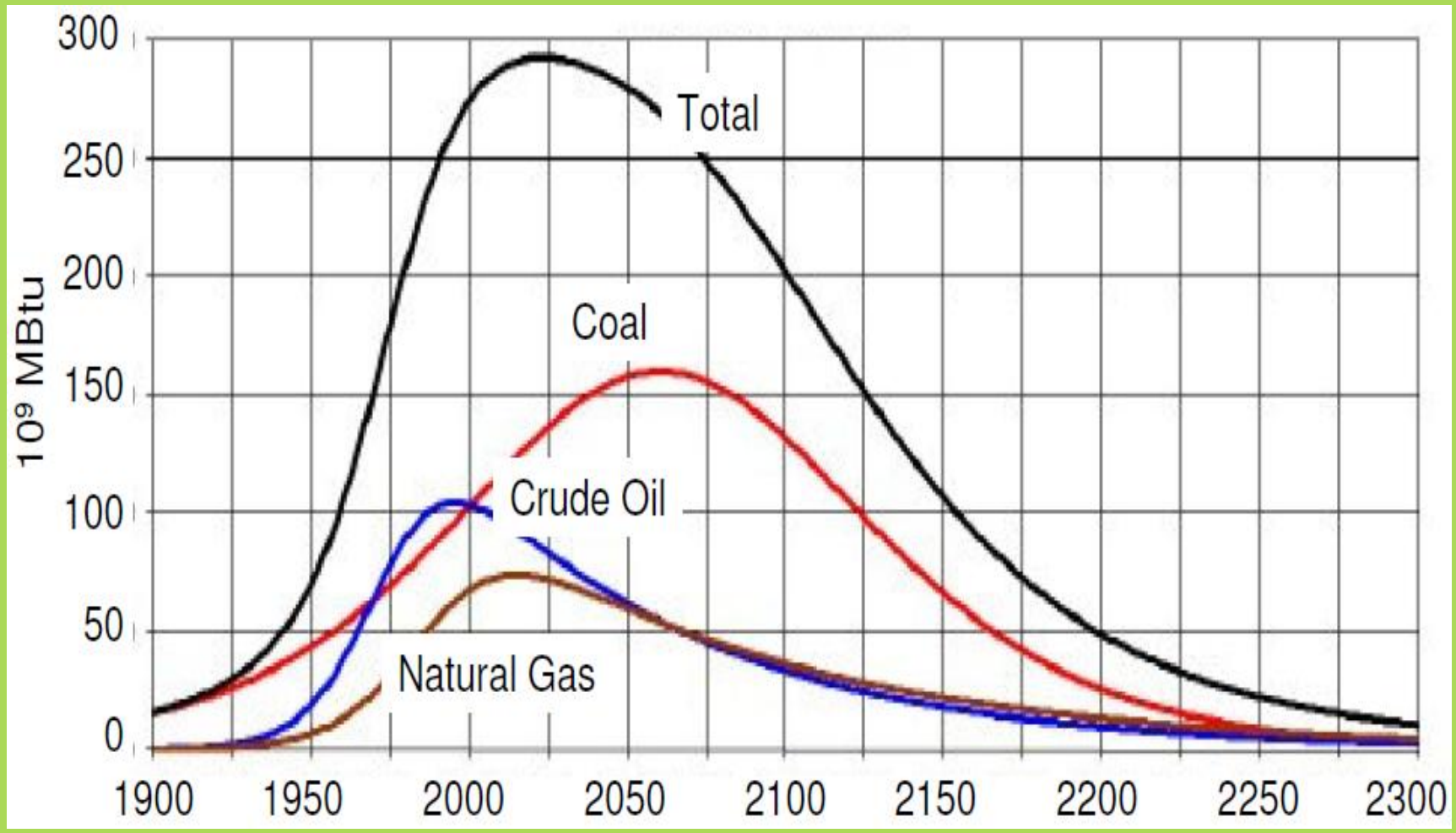
Highlights

- Introduction
- Integration issues of Renewable Energy
- Microgrid and Distributed Generations
- AIT and Research in Energy Field of Study
- Summary

Introduction

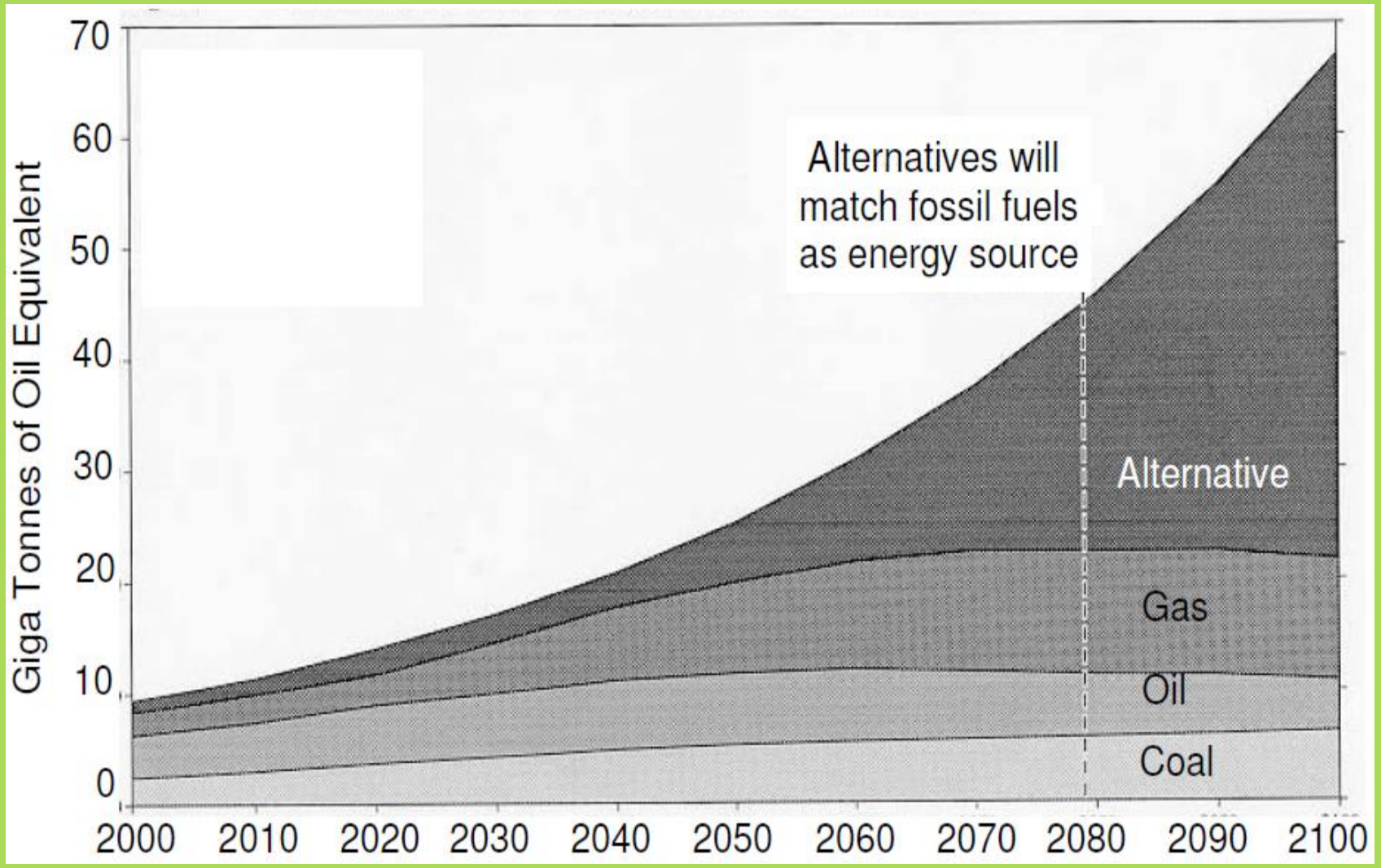
Finite Supply of Fossil Fuel



http://www.roperld.com/science/energy.htm

Introduction

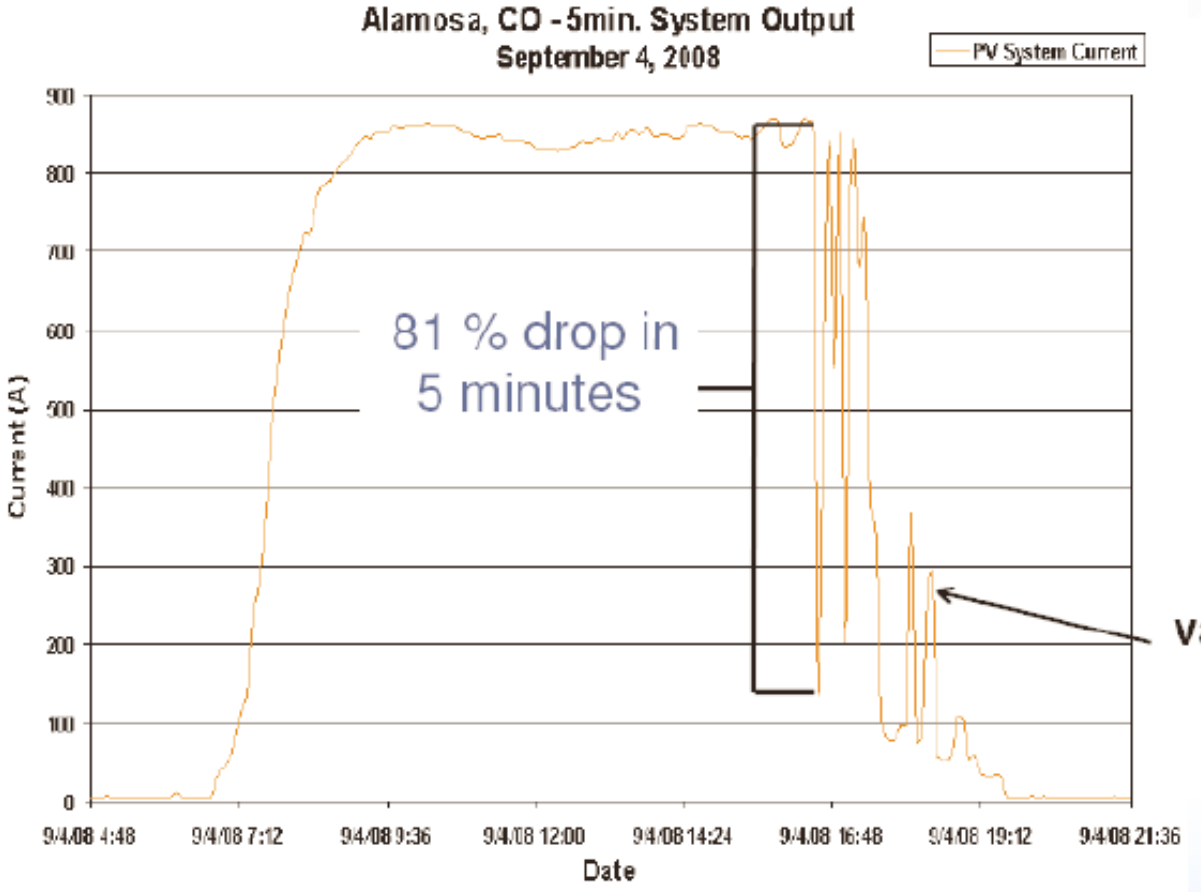
Evolution Trend of Energy Sources



http://www.kkrva.se/images/energi/odell_fig2.jpg

Integration issues of Renewable Energy

Solar Energy Sources are Highly Variable



Output from an 8MW solar PV panel in Colorado on 9/4/08

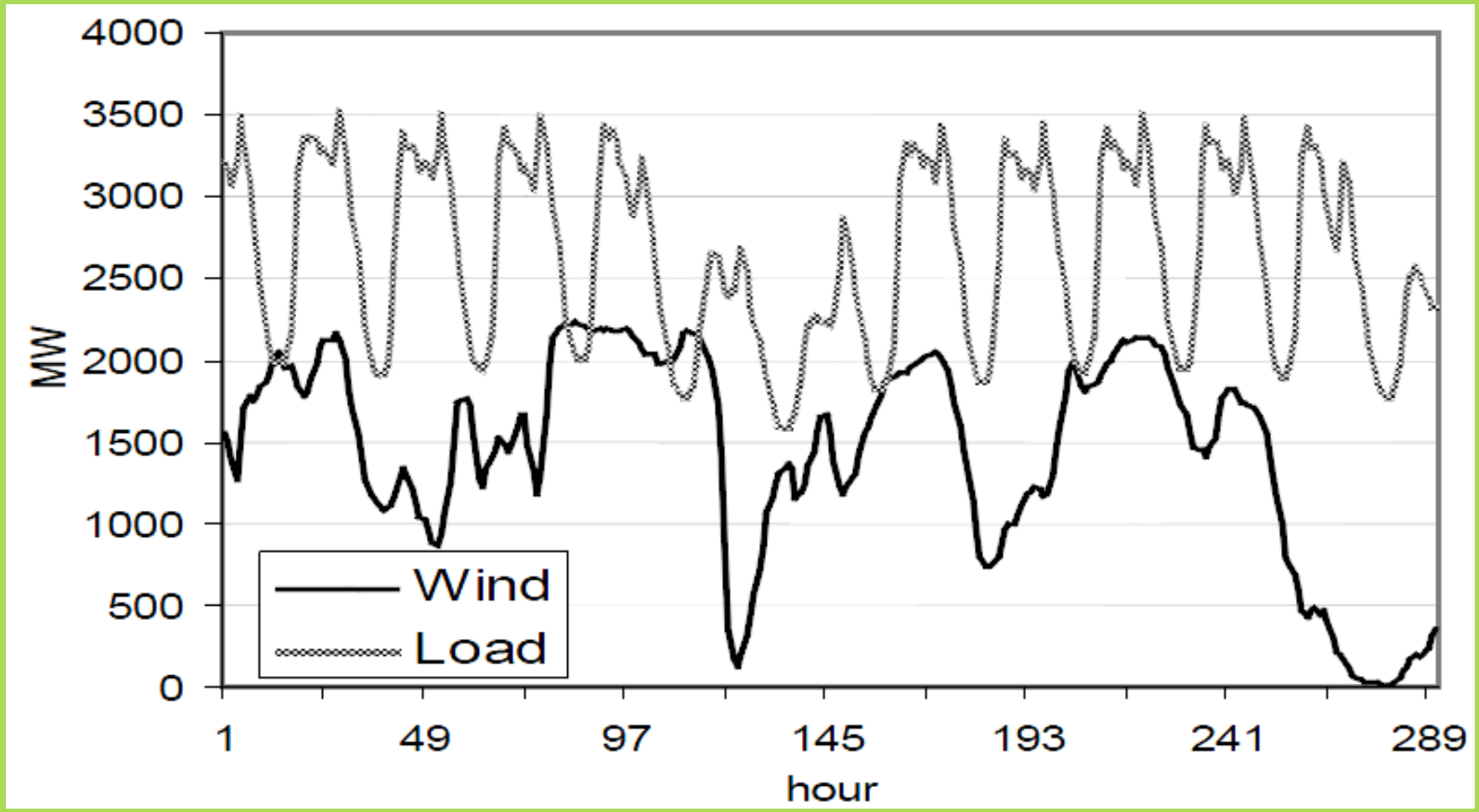
High variability due to clouds

Demand Response must be integrated

Source: US Dept of Energy

Integration issues of Renewable Energy

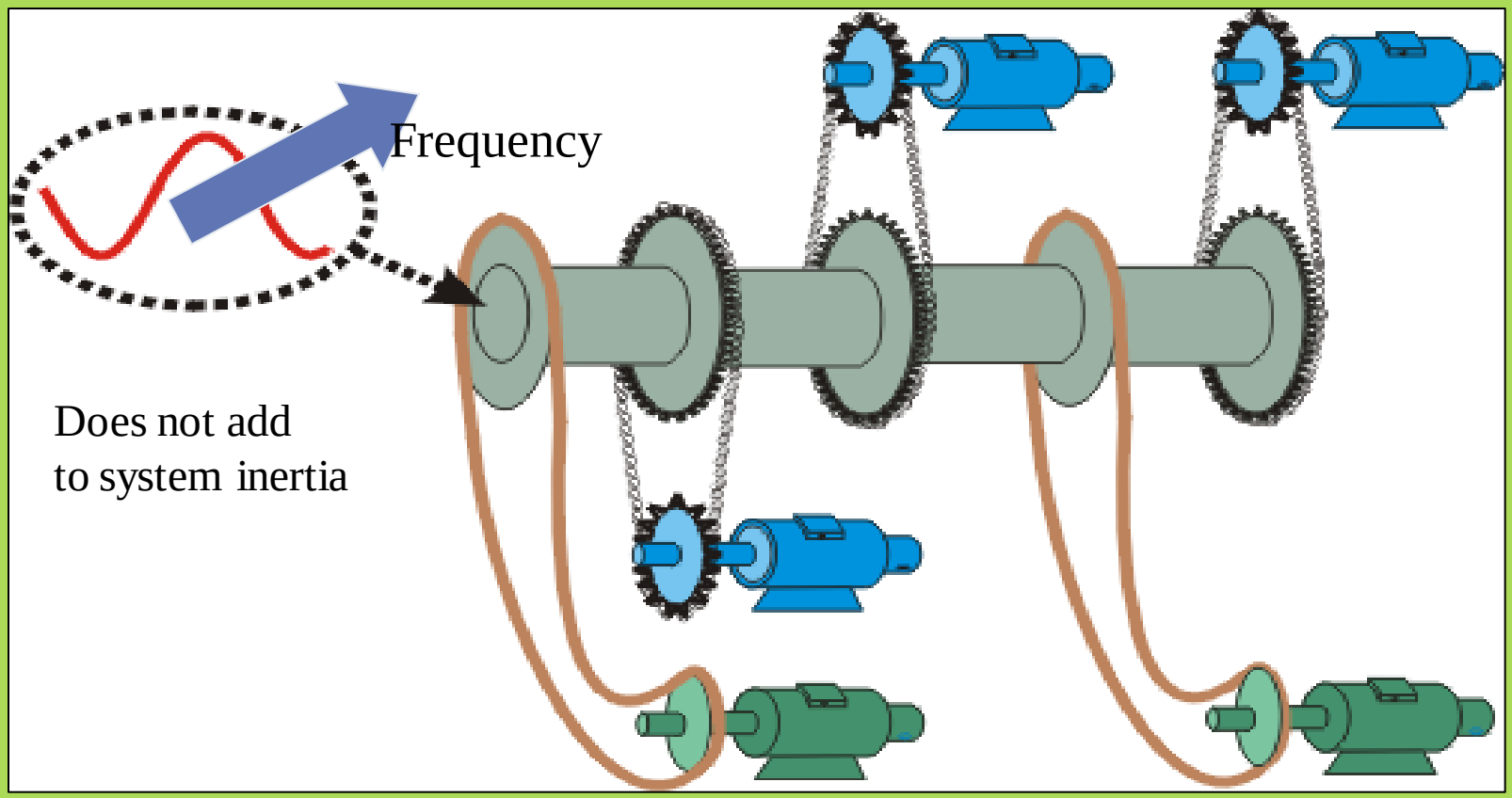
Wind Energy Sources are too Highly Variable



(Holttinen, 2007)

Integration issues of Renewable Energy

Supply demand balance: Why curtail wind/solar?

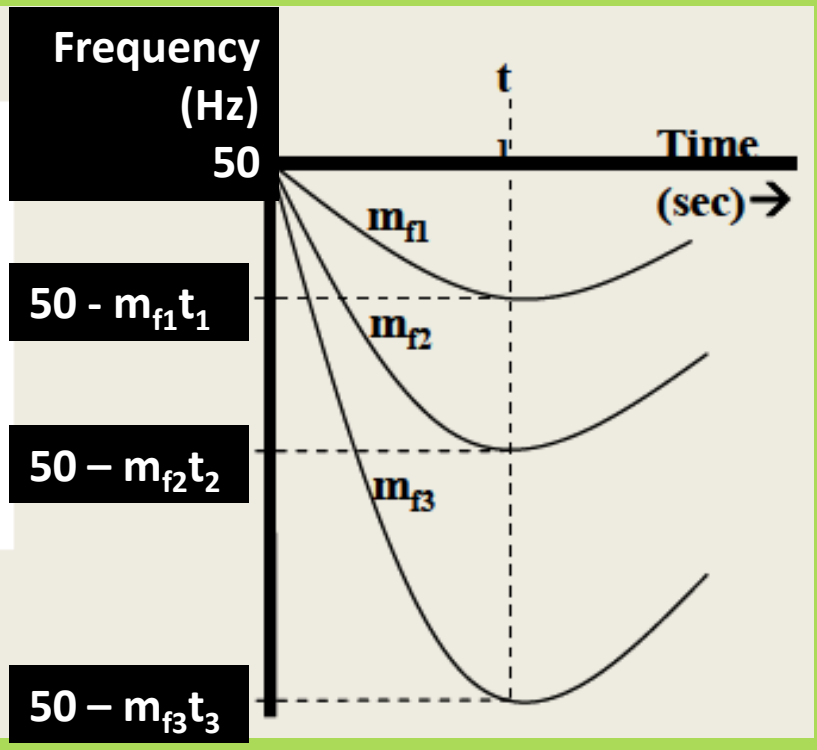


Ref.: Mullane, A. and O'Malley, M.J., "The inertial-response of induction-machine based wind-turbines", *IEEE Transactions on Power Systems*, Vol. 20, pp. 1496 – 1503, 2005.

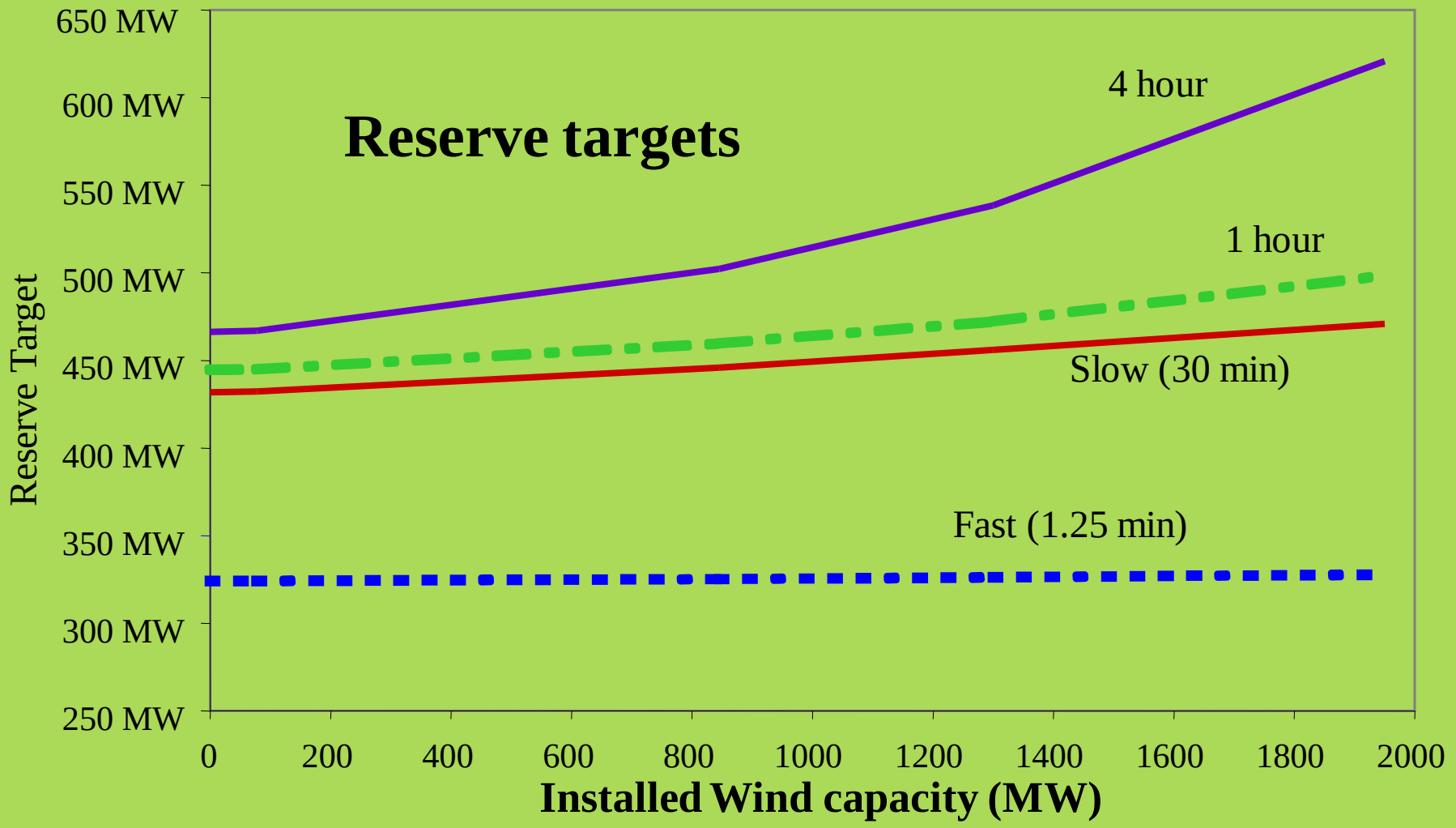
Integration issues of Renewable Energy

Transient frequency control

$$\frac{d\overline{\Delta f}}{dt} = \frac{-\Delta P_L f_{\mathrm{Re}}}{2\sum_{i=1}^{n} H_i} \equiv m_f$$



Integration issues of Renewable Energy



ILEX Energy, UCD, QUB and UMIST, "Operating reserve requirements as wind power penetration increases in the Irish electricity system", Sustainable Energy Ireland, 2004.

Reserve targets shown for different time frames – fast to slow – increases due to forecast errors and higher probability of events happening.

Integration issues of Renewable Energy

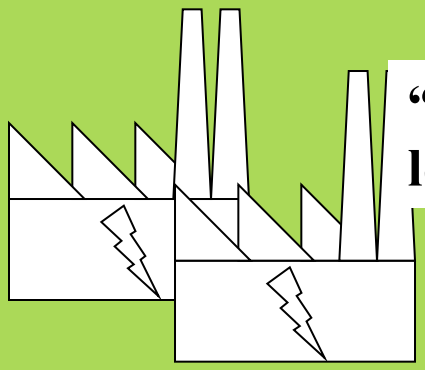
Supply demand balance: Why curtail wind?

Night time Demand

System Operator

Must curtail this wind to keep supply demand balance

MW



"Must run level"

Wind generation + "must run level"

Time

Microgrid and Distributed Generations

- Microgrid concept assumes a cluster of loads, micro-sources and storage operating as a single system to:
  - Presented to the grid as a single controllable unit (impacts system reliability)
  - Meets customers needs (such as local reliability or power quality)
- Microgrid can manage dispatchable generation and resource control systems for campuses, industrial complexes, electric cooperatives, small communities and distribution utilities.
- Safe, controllable and reliable microgrids integrating renewable generation are complimentary infrastructure with customer assets that increase grid reliability, stabilize long-term energy costs, and mitigate negative environmental impact.

Microgrid and Distributed Generations

- Provide energy access to those away from main grid.
- Increase energy access by optimization and utilization of energy resources.
- DG can also offer additional value to the grid system operators by:
  - Deferral of upgrades to transmission and distribution systems;
  - Reduction of losses in the distribution system; and
  - Provision of network support or ancillary services
- Distributed Generation by its very nature is a game changer for utilities.
- Countless dispersed points of generation.

Microgrid and Distributed Generations

Utility impacts:

- Increased penetration of renewable energy into the generation mix
- Technology upgrades within the utility
- New systemic impact occurring behind the meter
- Distributed energy resources will likely become the normal state; therefore, how do we integrate:
  - analog-centric power system
  - digital-centric information infrastructure
- Responding to these issues requires a new approach

Microgrid and Distributed Generations

Changes in the Network:

- Consumer engagement with resources to solve power issues locally
- Two-way power flow in distribution
- As prices increase, local renewables will increase in residential, commercial, and industrial
- Imperative to transform from passive to active control in distribution
- New ways for distribution to become a transmission resource

Microgrid and Distributed Generations

Distributed Generations

Benefits

- Improved grid reliability
- “Green” alignment
- Improved energy use and fuel costs
- Improved operating efficiency
- Market participation
- New revenue sources

Risks

- Slow adoption
- Lack of control systems
- No history of aggregation success
- Lack of incentives
- Few investors
- Regulatory hurdles
- Lack of education

Microgrid and Distributed Generations

Microgrid "Cells"

- Ideal for…
  - University Campus
  - Business Park
  - Islands
  - Municipality
  - Utility Distribution
  - Military Base
- Owned by…
  - Customer
  - Developer
  - Utility
  - Investment trusts

- Multiple microgrids will emerge locally
- Participate in grid and market support
- They will be aggregated
- They will be networked
- Transactive markets will emerge
- Individually, each may offer unique capabilities
- Central management will emerge

Microgrid and Distributed Generations

The grid of tomorrow

DISTRIBUTED RESOURCES	POWER GRID MANAGEMENT	CUSTOMER POWER MANAGEMENT
▸Distributed generation interconnection ✓Solar ✓Wind ✓Fuel cells ✓Batteries ▸Energy storage	▸Real-time monitoring ▸Transmission/ distribution automation ▸Demand response (adjusting to grid conditions) ▸Broadband over power lines (BPL)	▸Smart meters ▸Smart buildings & equipment ▸Smart appliances ▸Plug-in hybrid electric vehicles (PHEVs) ▸Voltage regulation/ Pre-set energy use

Over the next 10 to 20 years, this industry can evolve more rapidly than ever before.

Asian Institute of Technology (AIT)

Schools

- School of Environment Resources and Development (SERD)
- School of Engineering and Technology (SET)
- School of Management (SOM)

Fields of study

- Agricultural Systems and Engineering
- Aquaculture and Aquatic Resources Management
- Environmental Engineering and Management
- Food Engineering and Bioprocess Technology
- Gender and Development Studies
- Natural Resources Management
- Pulp and Paper Technology
- Regional and Rural Development Planning
- Urban Environment Management
- ENERGY

Areas of Specialization

- Electric Power System Management
- Energy Economics and Planning
- Energy Technology
- Energy Business Management (New)

Interdisciplinary

- Cleaner Production

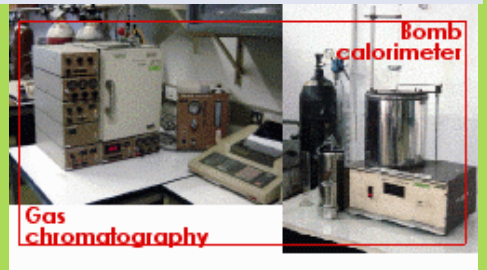
ENERGY *Field of Study*

Addresses these energy issues …

- Energy and climate change
- Renewable energy and energy efficiency
- SmartGrid and renewable energy
- Energy systems (supply and demand) management
- Restructuring of energy industries
- Energy economics and planning
- Rural electrification and distributed generation
- Integration of renewable energy in power grid
- Demand-side management
- Integrated resources planning

Energy Laboratory

- Energy laboratory facilities include two indoor laboratories, an Energy Park, and a meteorological station.
- The indoor laboratories are equipped with experiment setups, testing apparatus and measuring equipment for thermal and electrical management studies.
- Energy computer laboratory has software for power system simulation, simulation of thermal equipment and modeling of energy system.
- Energy Park covers 3980 square meters outdoor research and demonstration facilities.
- The meteorological station measures and records direct, diffuse and global solar radiation and other meteorological and daylighting data.



Recent Collaborations

- **Academic**
  - **VSIS, India – 2 stage program**
  - **UNSRI, Indonesia – dual degree program**
  - **PEA, Thailand**
  - **EVN, Vietnam**
  - **Unesco, Jakarta – e learning**
  - **Sida – NUOL, Sweden, Lao PDR**
  - **CANMET, Canada**
  - **NoRAD, Norway**

  - **Faculty from University of Tokyo, Hanoi University of Technology**

  - **Climate change – interdisciplinary (with foreign universities)**
  - **Energy Business Management –with SOM**
  - **Professional programs (1 year) in Energy Economics and Planning; Electric Power systems management and Energy Technology in Vietnam**

Recent Collaborations

- **Research**
  - **GNESD, Denmark**
  - **UNEP**
  - **ADEME, France**
  - **UNIDO, Austria**
  - **ADBI, Japan**
  - **EEP in the Mekong**

- **Outreach**
  - **PEA, Thailand**
  - **EGAT, Thailand**
  - **MEA, Thailand**
  - **SSEB/DoE, USA**
  - **GNESD**
  - **IGES**
  - **ESCAP/APCTT**

Some selected research projects (recent)

- Microhydro – PV Hybrid System.
- Pilot Appraisal of Low Carbon Technology Innovation and Diffusion in Thai Manufacturing Sectors.
- Actions towards Resources-efficient and Low carbon cities in Asia.
- E-learning course on Renewable energy and energy policy.
- Green House gas emission mitigation at AIT: Reducing GHG Emission Through Energy Conservation.
- Bio-energy for Rural Development and Poverty Alleviation
- Energy Efficiency using RETScreen and Integration of RETScreen Version 4 in education and Training.
- Capacity Development on Clean Coal Technology and Carbon Sequestration.
- Biomass Gasification study in the Mekong Region. (EEP Mekong)
- Technology Needs Assessments in Asia for Climate Change Mitigation. (TNA)
- Energy and Sustainable Development: Issues and Strategies (ESD).

Summary

- Depletion of conventional energy resources
- Alternative energy sources emerging as an options
- Options are enormous but challenges too
- Distributed generations could be a significant game changer
- Use of DGs affected by grid integration issues
- Microgrid would be one options to above integration issue
- Demand response would be another option
- Investment issues in energy sector

Thank you for attention!