100% renewable energy scenarios for Myanmar?

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Structure of the presentation

1. The simple example of a 100% RE island
2. The challenge of meeting residual load
3. Hydropower to match residual load
4. The renewable energy resources in Myanmar
5. The future electricity demand of Myanmar
6. Why coal is not the future of electricity production
7. A first 100% RE power scenario for Myanmar
8. The cost of a 100% RE power supply for Myanmar
9. Conclusions

Meeting residual load with large shares of fluctuating renewable energy sources

The example of the island of Mahé in the Seychelles

Present electricity demand and supply in Mahé

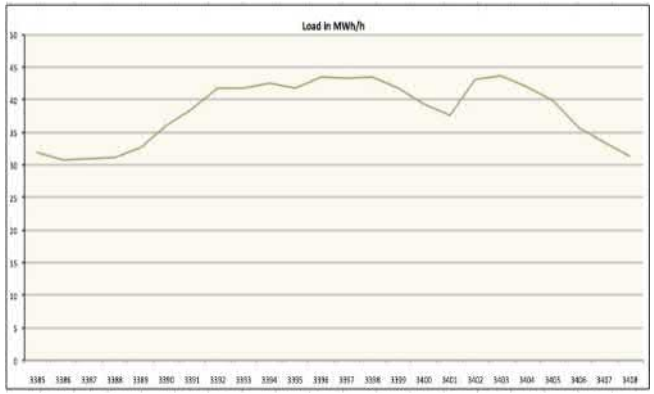
1. Electricity production 2014: 320 GWh/a
2. Peak load: 51.6 MW
3. Total operating expenses: 730.2 M SCR
4. Fuel costs: 651.1 M SCR
5. Total costs per kWh: 2.33 SCR/kWh
6. Fuel costs per kWh: 2.08 SCR/kWh
7. Average rate charged (2014) 3.85 SCR/kWh

8. Virtually all PUC production based on HFO/diesel

   14 low and high speed diesel 74 MW (diesel)

   8 wind turbines 6 MW

Load curve May 22nd



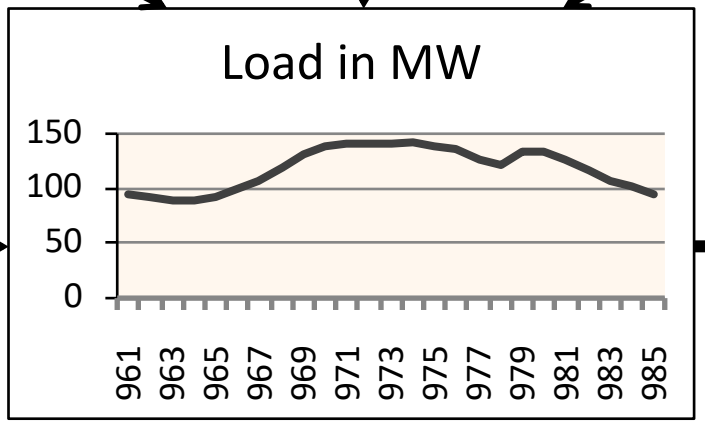
A plausible 100% renewable power system for Mahé

125 MW PV

1 GWh PSH

50 MW wind

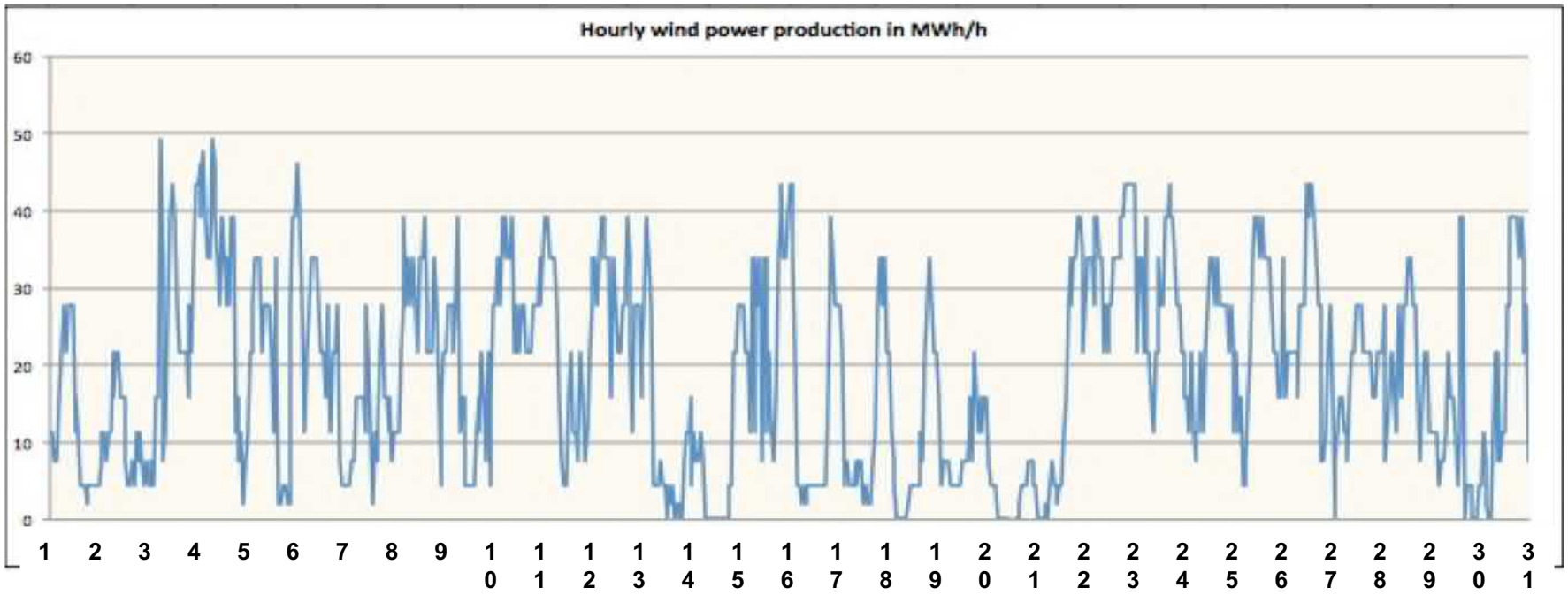
25 GWh biomass



Wind energy on Mahé in May

1. Size of the island: 152 km^2
2. Theoretical potential on shore: 1.5 GW
3. Costs per kWh (wind 2010): 0.827 SCR/kWh

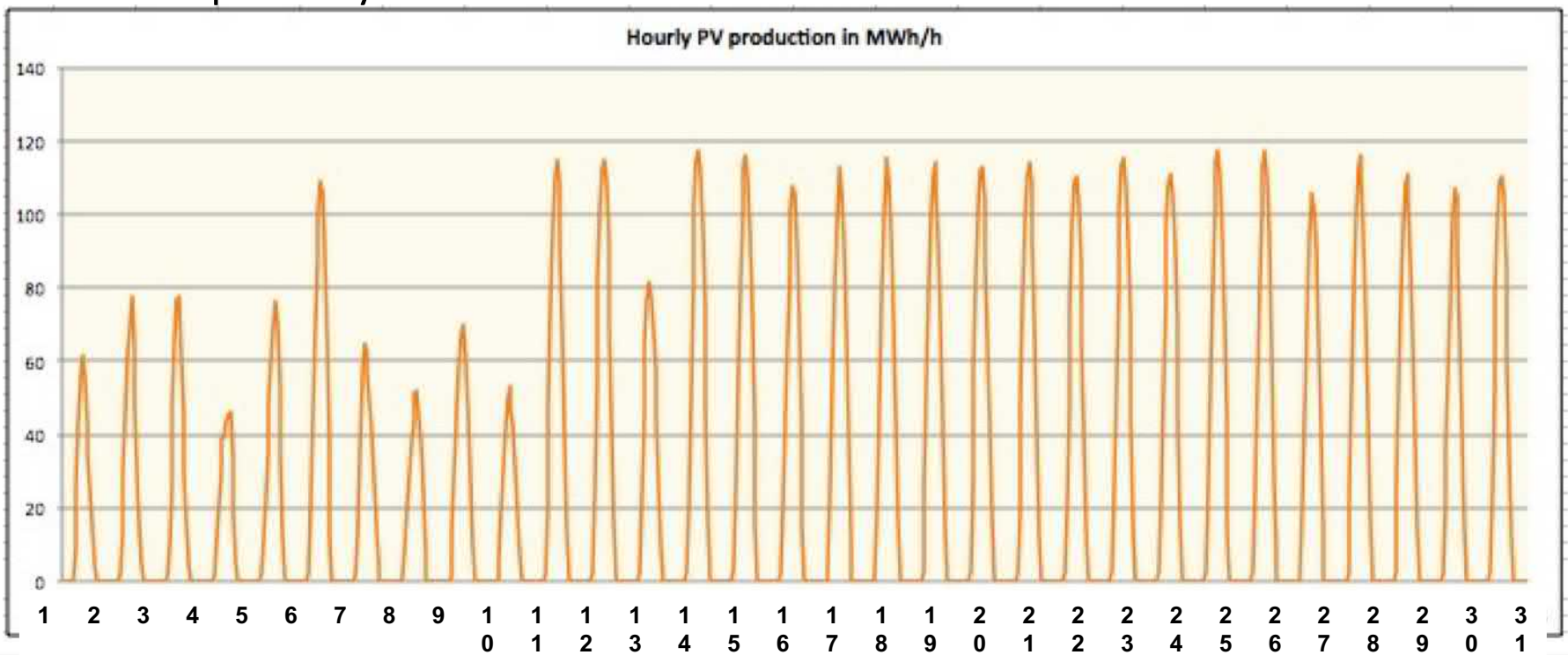
Example: May 50 MW installed



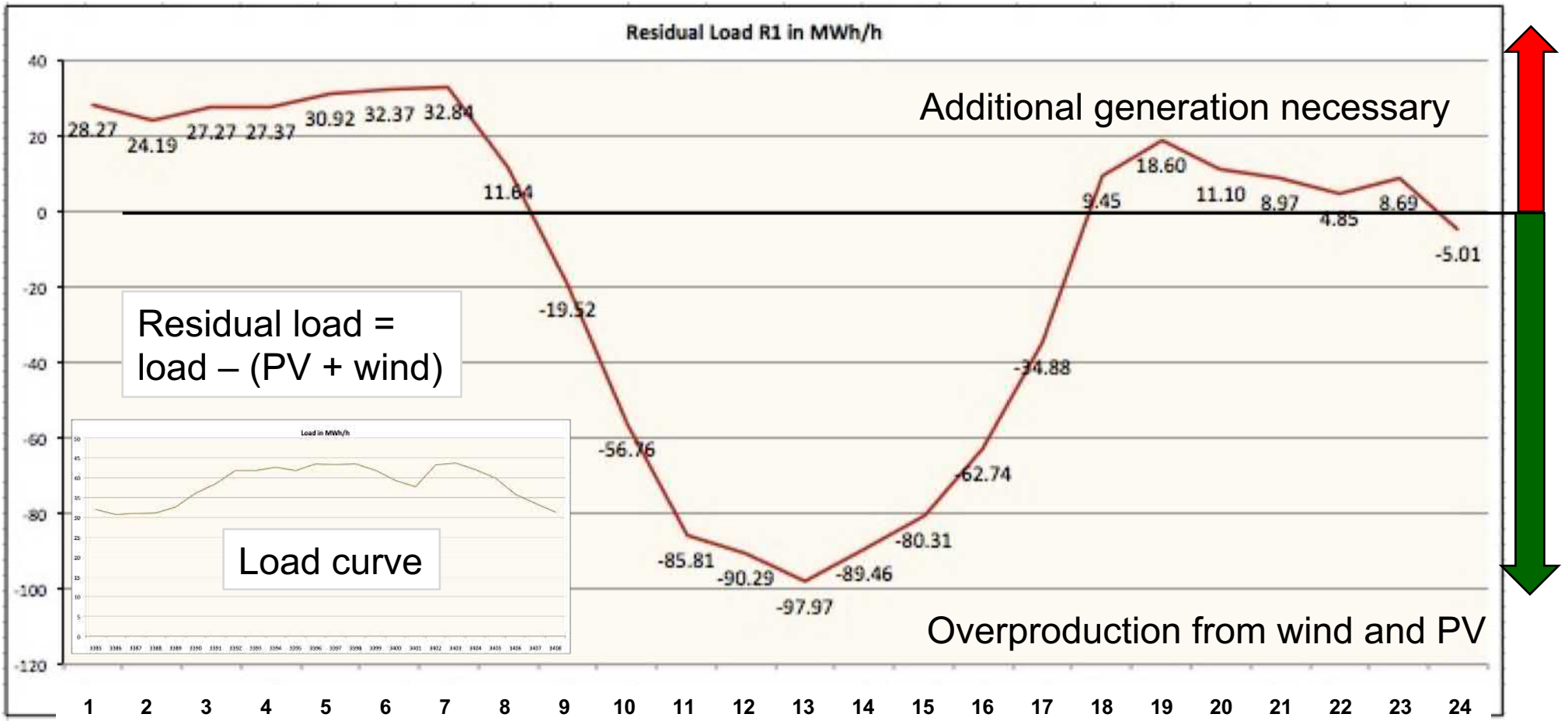
PV on Mahé in May

1. Size of the island: 157 km^2
2. Theoretical PV potential: 1 950 GW
3. Costs per kWh: 1.49 SCR/kWh

Example: May 125 MW installed

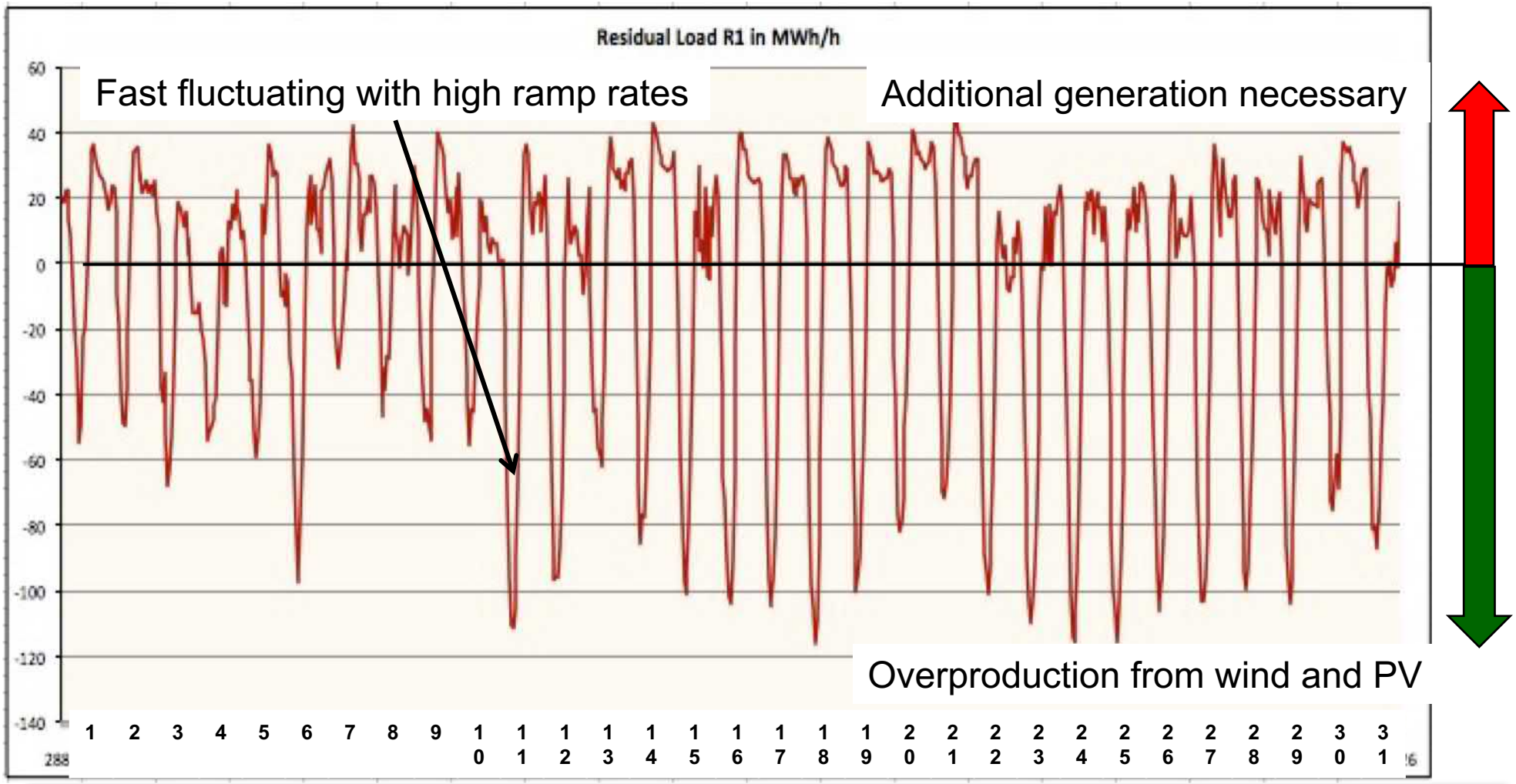


Residual load for 100% REN Mahé (May 22nd)



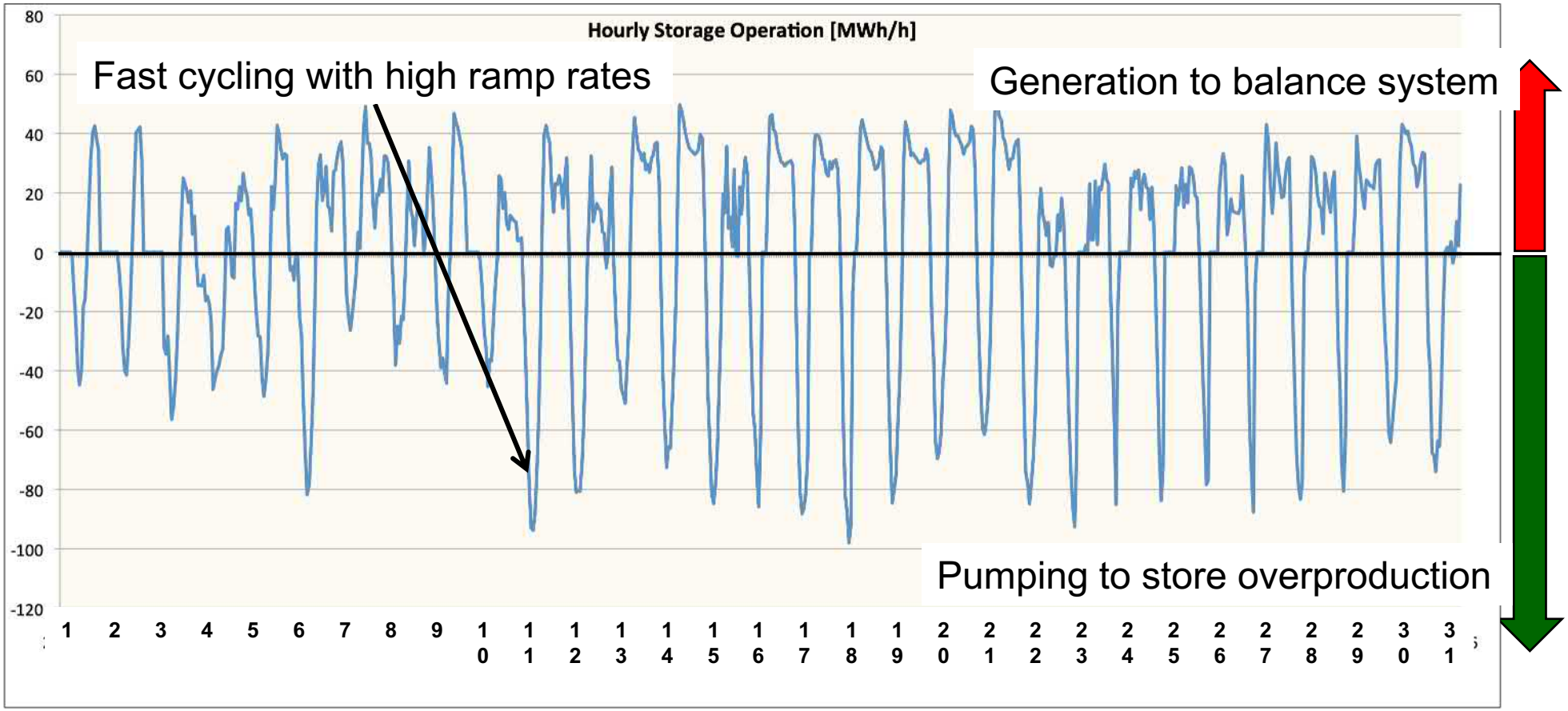
Residual load for May

(Using load data from 2014 and wind and solar data from 2010)

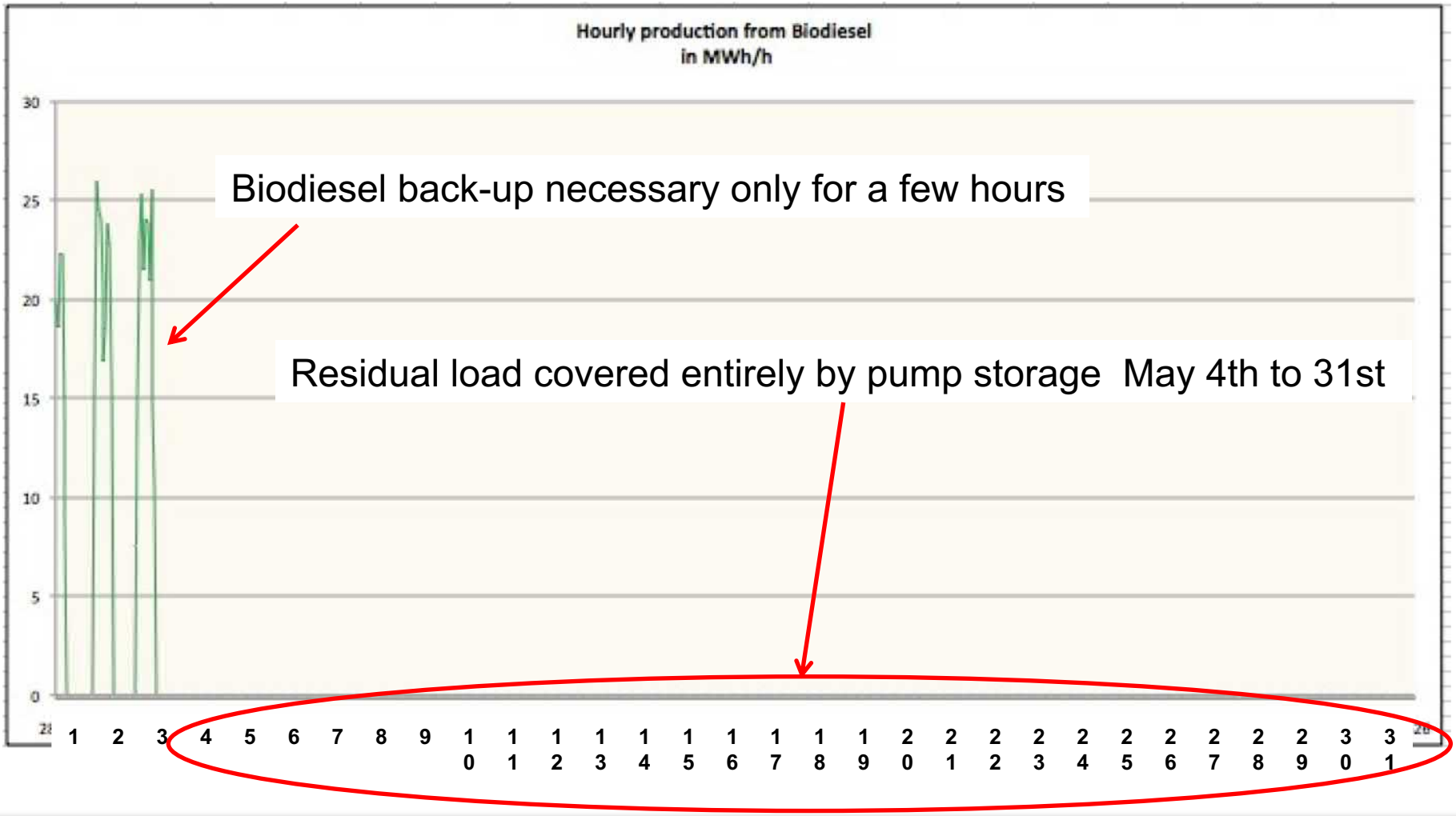


Pump storage operation in May

(Using load data from 2014 and wind and solar data from 2010)



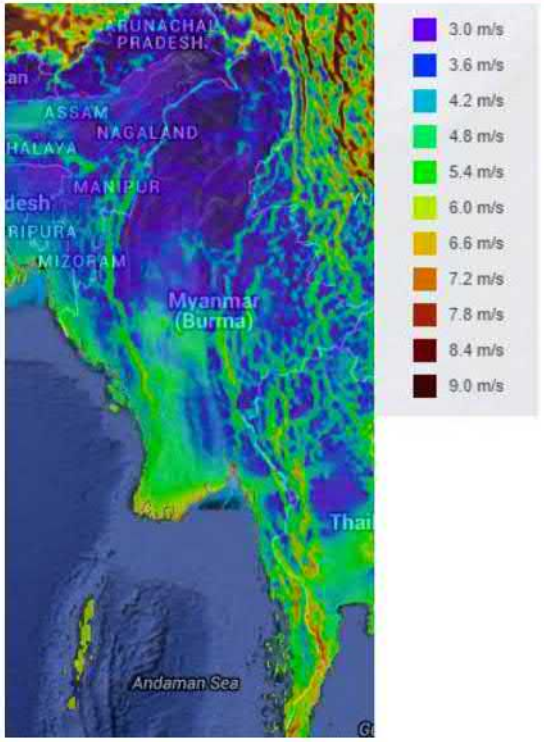
Use of biomass in May to match the load not met by wind, PV or pump storage



Results of a first 100% RE study on Myanmar (IES and MKE 2017)

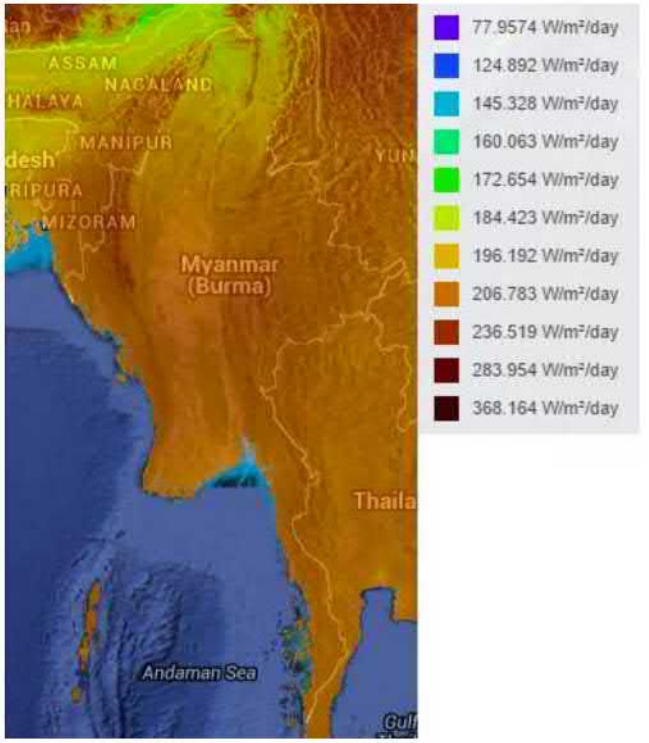
Myanmar has good wind and solar energy resources

Figure 15 3TIER's Global Wind Dataset 5km onshore wind speed at 80m height[6]



Source: IRENA Global Atlas for Renewable Energy (3TIER Global Wind Dataset)

Figure 19 3TIER's Global Solar Dataset (3km in W/m^2) for GHI



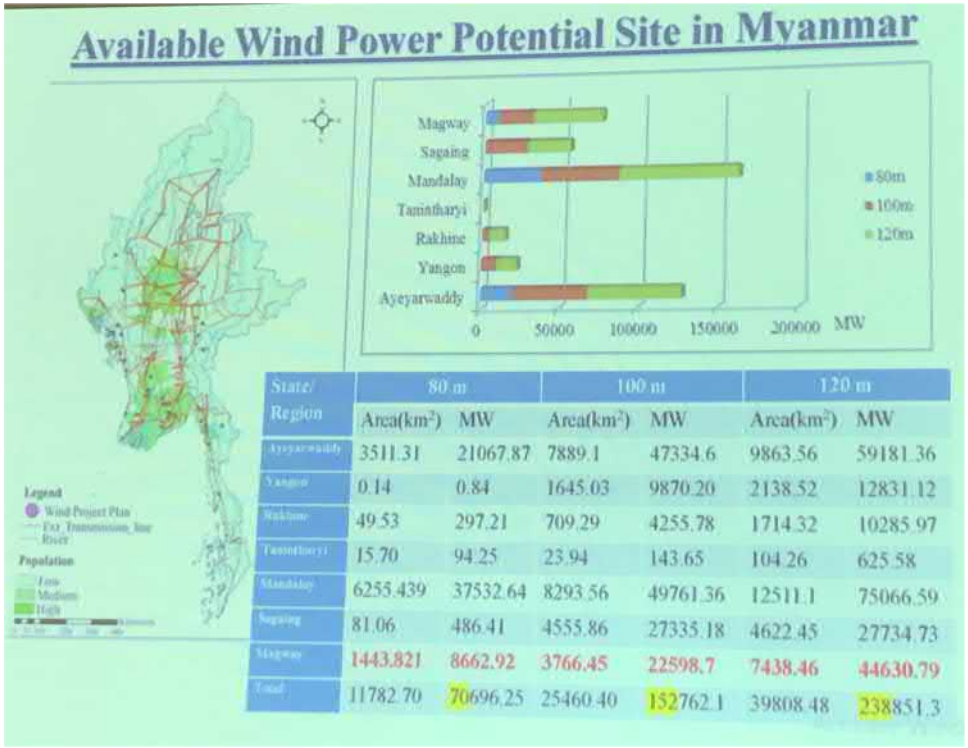
Source: IRENA Global Atlas for Renewable Energy (3TIER Global Solar Dataset)

But: No publicly available hourly wind measurement data!

Source: IES and MKE 2017

Myanmar's wind energy resources may be very substantial, but we lack wind data!

Source: IES and MKE 2017



State/ Region	80 m		100 m		120 m	
	Area(km²)	MW	Area(km²)	MW	Area(km²)	MW
Ayeyarwaddy	3511.31	21067.87	7889.1	47334.6	9863.56	59181.36
Yangon	0.14	0.84	1645.03	9870.20	2138.52	12831.12
Rakhine	49.53	297.21	709.29	4255.78	1714.32	10285.97
Tanintharyi	15.70	94.25	23.94	143.65	104.26	625.58
Mandalay	6255.439	37532.64	8293.56	49761.36	12511.1	75066.59
Sagaing	81.06	486.41	4555.86	27335.18	4622.45	27734.73
Magway	1443.821	8662.92	3766.45	22598.7	7438.46	44630.79
Total	11782.70	70696.25	25460.40	152762.1	39808.48	238851.3

Source: Slide shown at a workshop of MoEE in January 2020

Estimates of up to 240 GW in wind energy potential!

But no information on possible output in TWh/a!

Myanmar's hydropower resource is excellent and biomass can contribute substantially

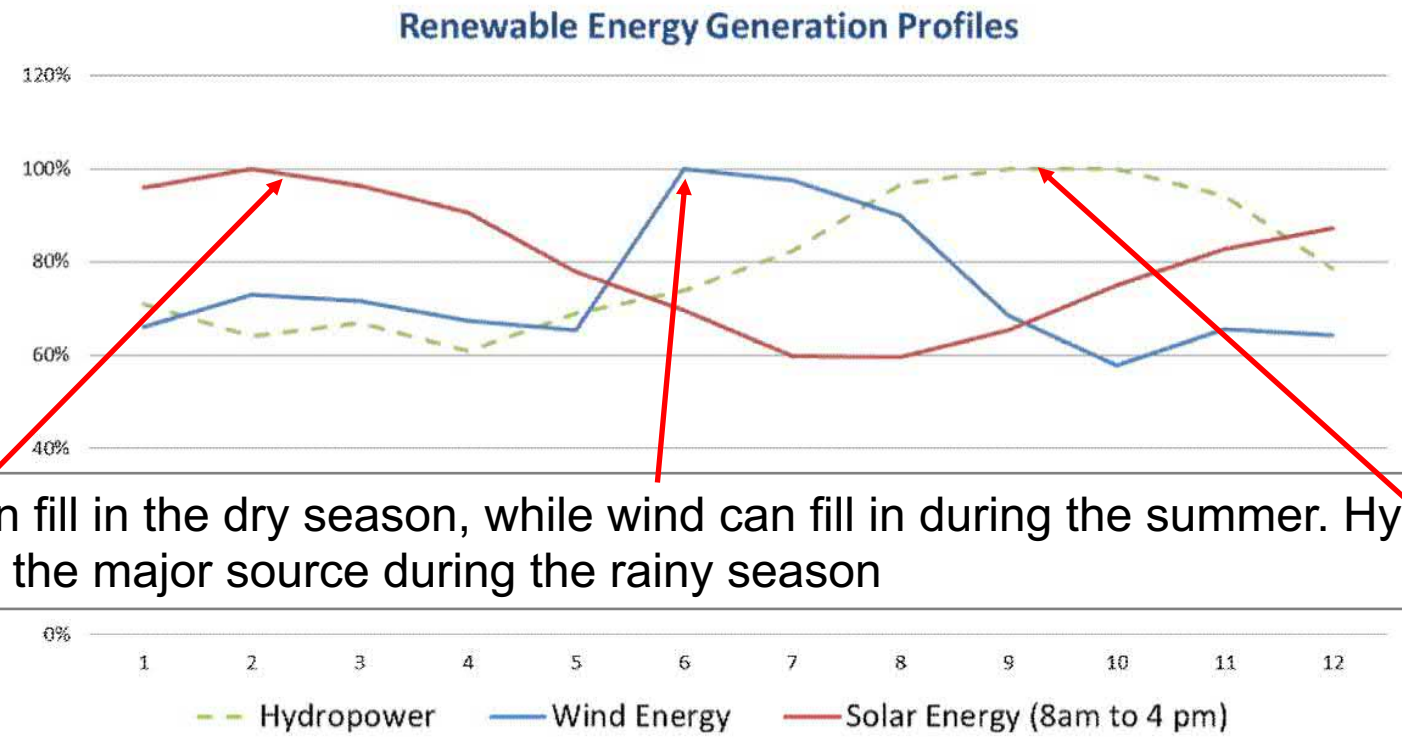
Table 5 **Summary of Estimated Renewable Energy Potential (Compiled from Various Sources and Analysis)**

Myanmar	Potential (MW)	Source and comments
Hydro (Large)	46,000	See Section 3.4
Hydro (Small)	231	See Section 3.4
Pump Storage	0	Lack of studies available
Solar	26,962 MW	Renewable Energy Developments and Potential in the Greater Mekong Subregion (ADB, 2015)
Wind Onshore	33,829	Renewable Energy Developments and Potential in the Greater Mekong Subregion (ADB, 2015)
Wind Offshore	No information available	Lack of studies available
Biomass	6,899	IES projections based on data from Renewable Energy Developments and Potential in the Greater Mekong Subregion (ADB, 2015)
Biogas	4,741	IES projections based on data from Renewable Energy Developments and Potential in the Greater Mekong Subregion (ADB, 2015)
Geothermal	400	See Section 3.7
Ocean	1,150	Ocean renewable energy in Southeast Asia: A review (2014), based on 5kW/m wave potential, 2300km coastline, 10% efficiency

Source: IES and MKE 2017

The seasonality of solar, wind and hydropower fits very well together

Figure 23 Seasonal Renewable Energy Generation Profiles



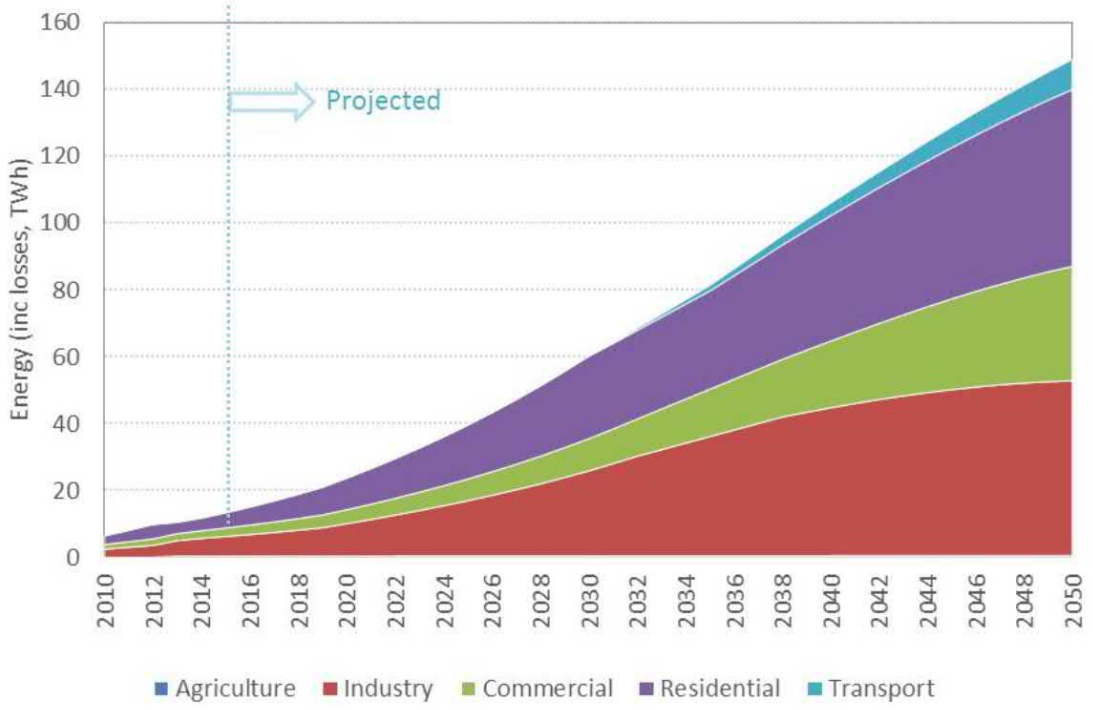
PV can fill in the dry season, while wind can fill in during the summer. Hydropower will be the major source during the rainy season

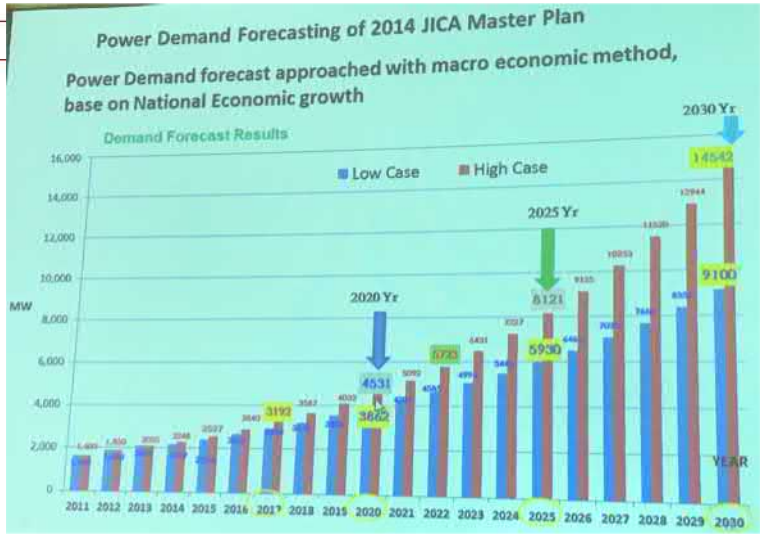
Source: Consultant analysis

Source: IES and MKE 2017

A sevenfold increase in electricity demand will need to be met by 2050 (according to IES and MKE)

Figure 31 Myanmar Projected Electricity Demand (2015-50, BAU)





Source: Slide shown at a workshop of MoEE in January 2020

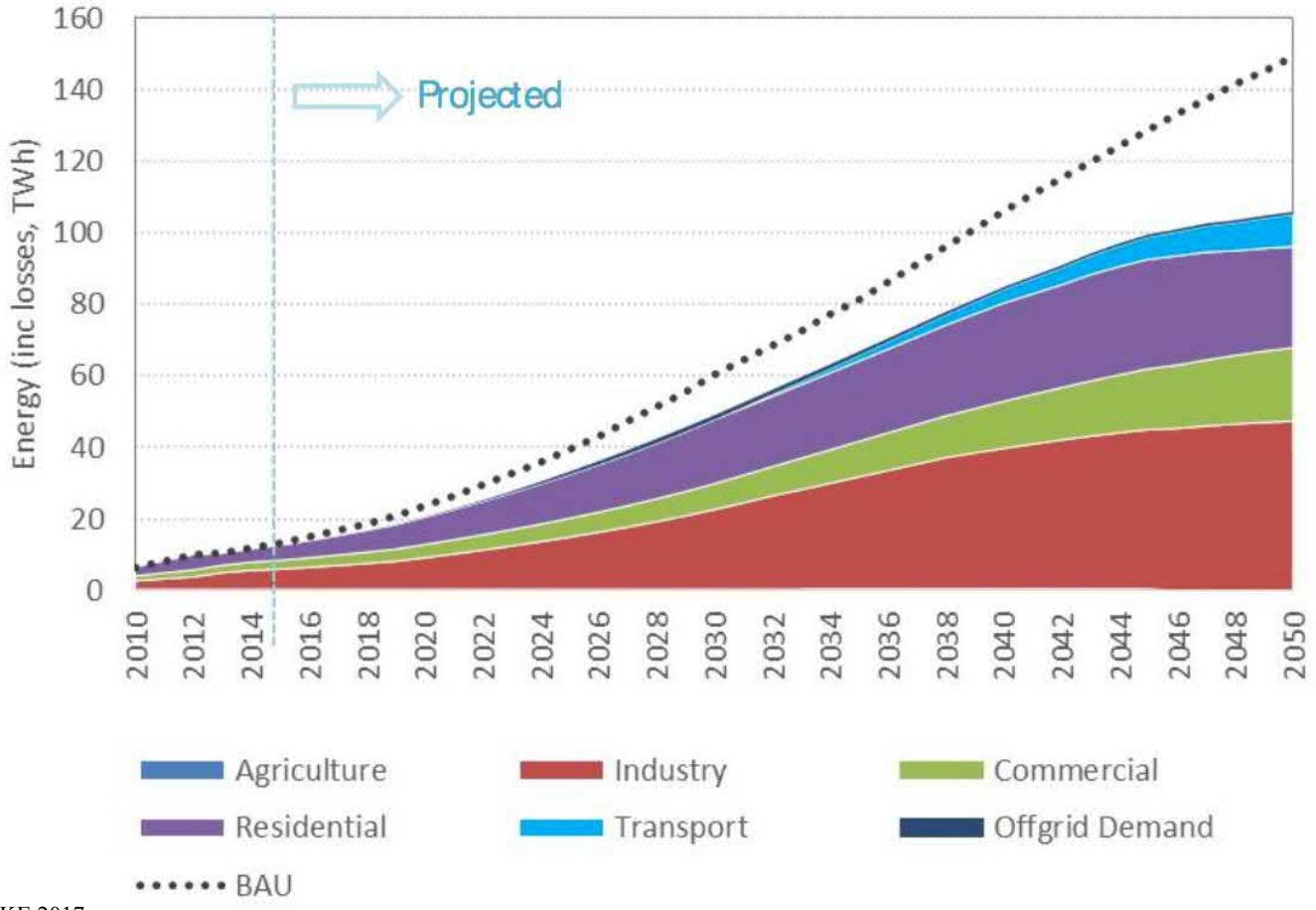
According to JICA Master Plan:

2014:	1696 MW
2020:	3862 MW (low case)
	4531 MW (high case)
2030:	9100 MW (low case / 535%)
	14542 MW (high case / 857%)

Source: IES and MKE 2017

Increased efficiency may reduce power demand by about 20% (IES and MKE 2017)

Figure 44 Myanmar Projected Electricity Demand (2015-2050, SES)



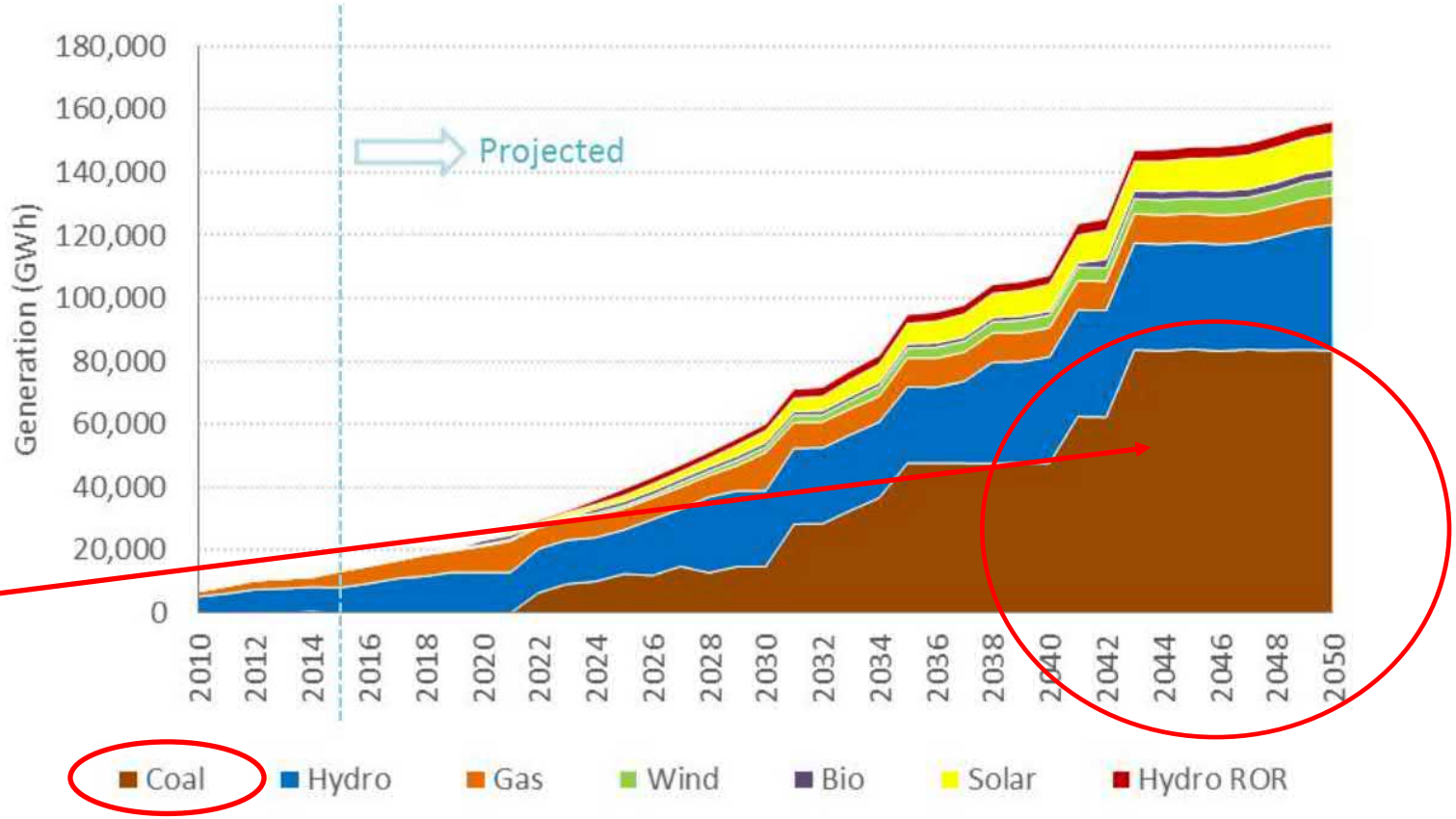
Source: IES and MKE 2017

In the **business-as-usual** case **coal** is supposed **to cover about 60% of the future power demand**

High CO2 emissions from coal fired power plants will not comply with the Paris agreement!

Those coal fired power plants will go bankrupt!

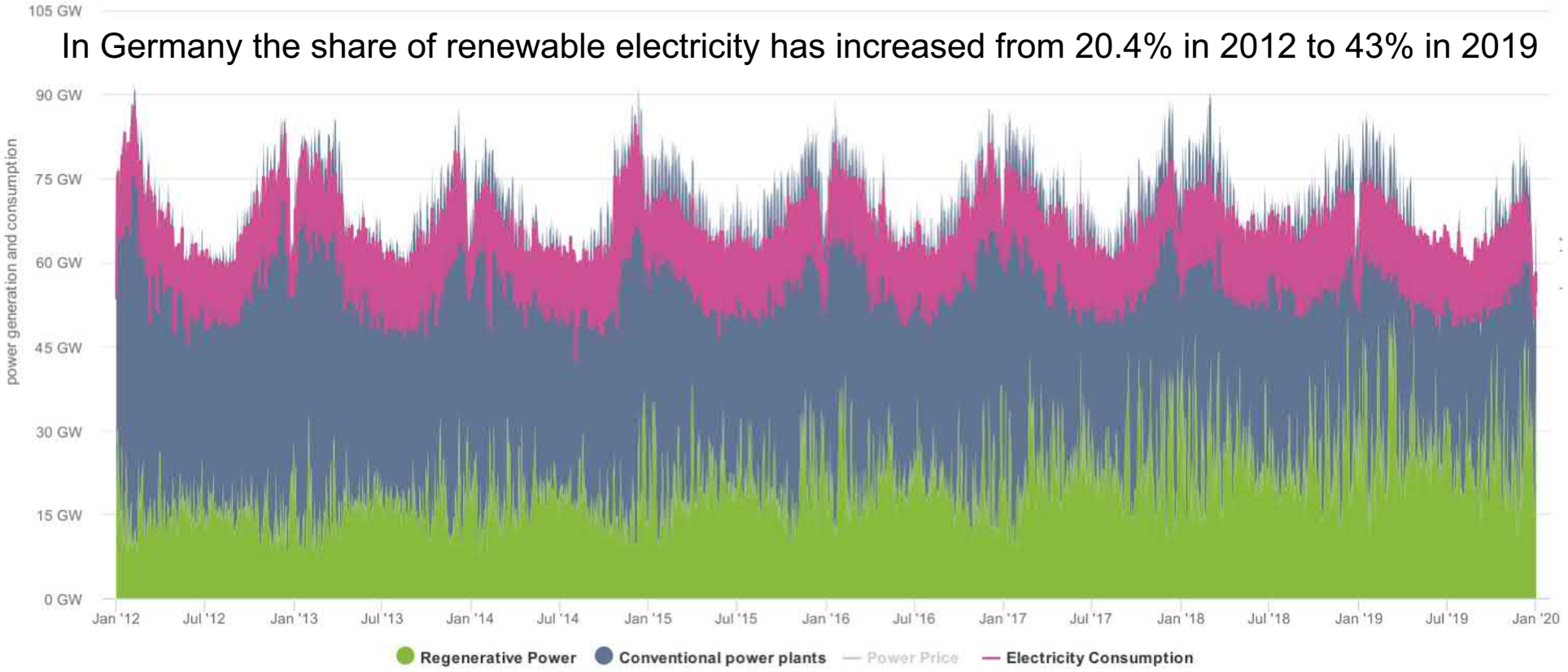
Figure 35 **Myanmar Generation Mix (BAU, GWh)**



Source: IES and MKE 2017

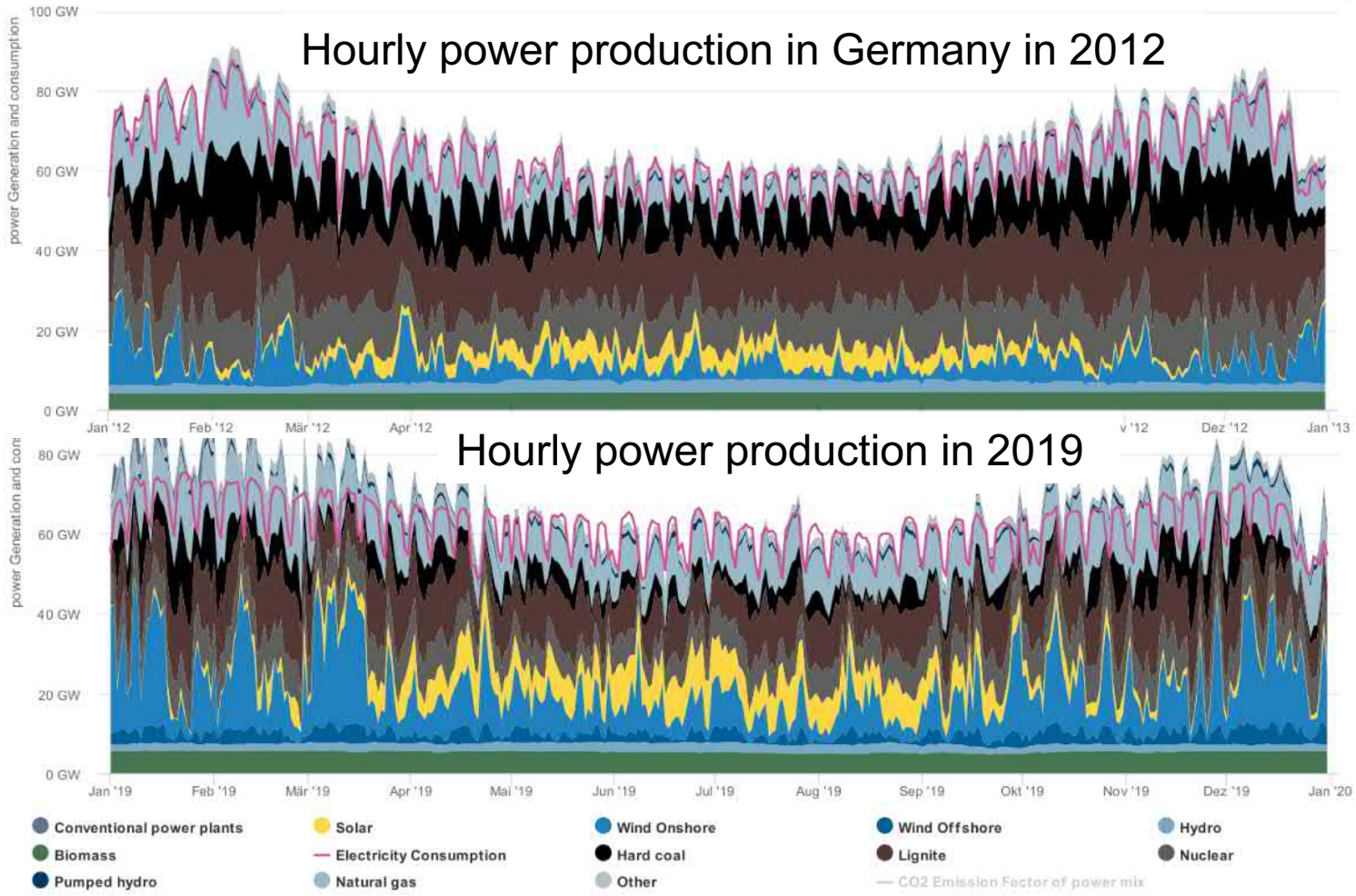
Increasing shares of wind and PV have a big impact on conventional power generation (Germany 2012 -2020)

In Germany the share of renewable electricity has increased from 20.4% in 2012 to 43% in 2019



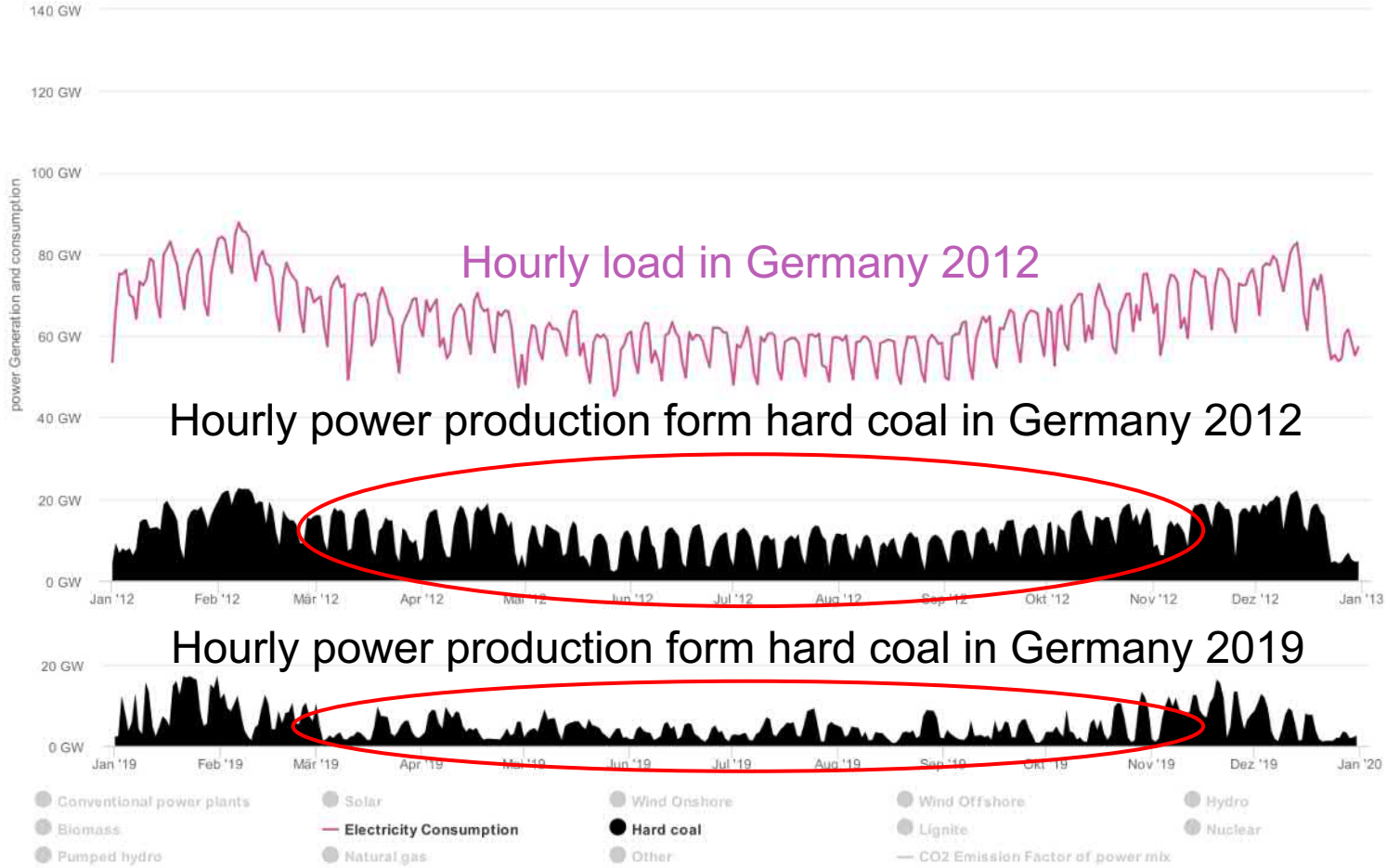
Agora Energiewende; Current to: 18.02.2020, 11:10

Increasing shares of wind and PV change the operation of conventional power plants fundamentally



Agora Energiewende; Current to: 18.02.2020, 11:10

Coal is forced out of the market as soon as wind and PV gain larger market shares!



In Germany hard coal power plants don't get the necessary operating hours any more due to high shares of renewable energy!

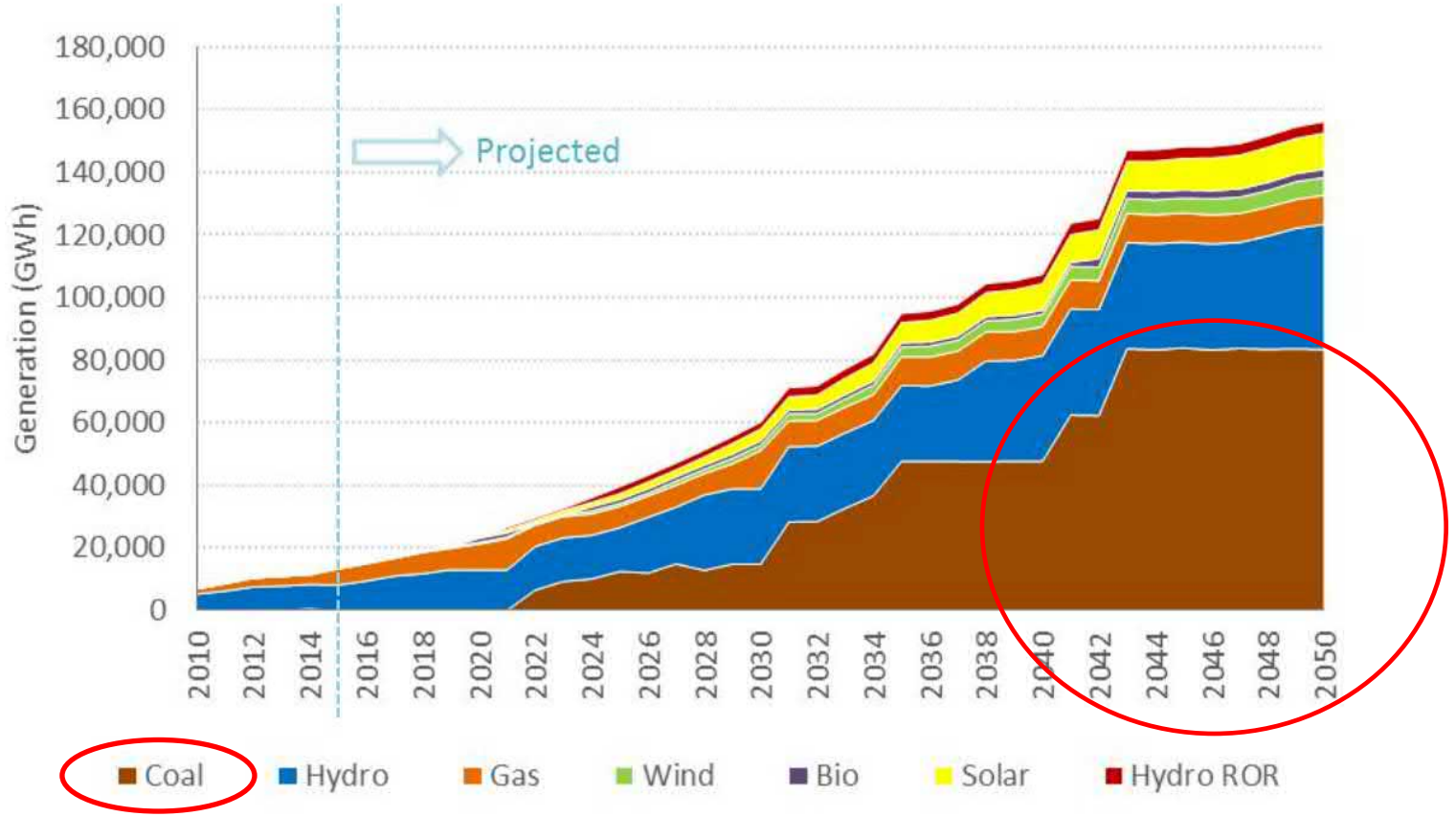
Full load hours decreased from 4418 to 2401 h/a for hard coal

(from 7545 to 5907 h/a for lignite and from 8250 to 7915 h/a for nuclear)

60% power from coal will not be a viable option for Myanmar

Coal fired power plants will go bankrupt or be an extreme economic burden for the country!

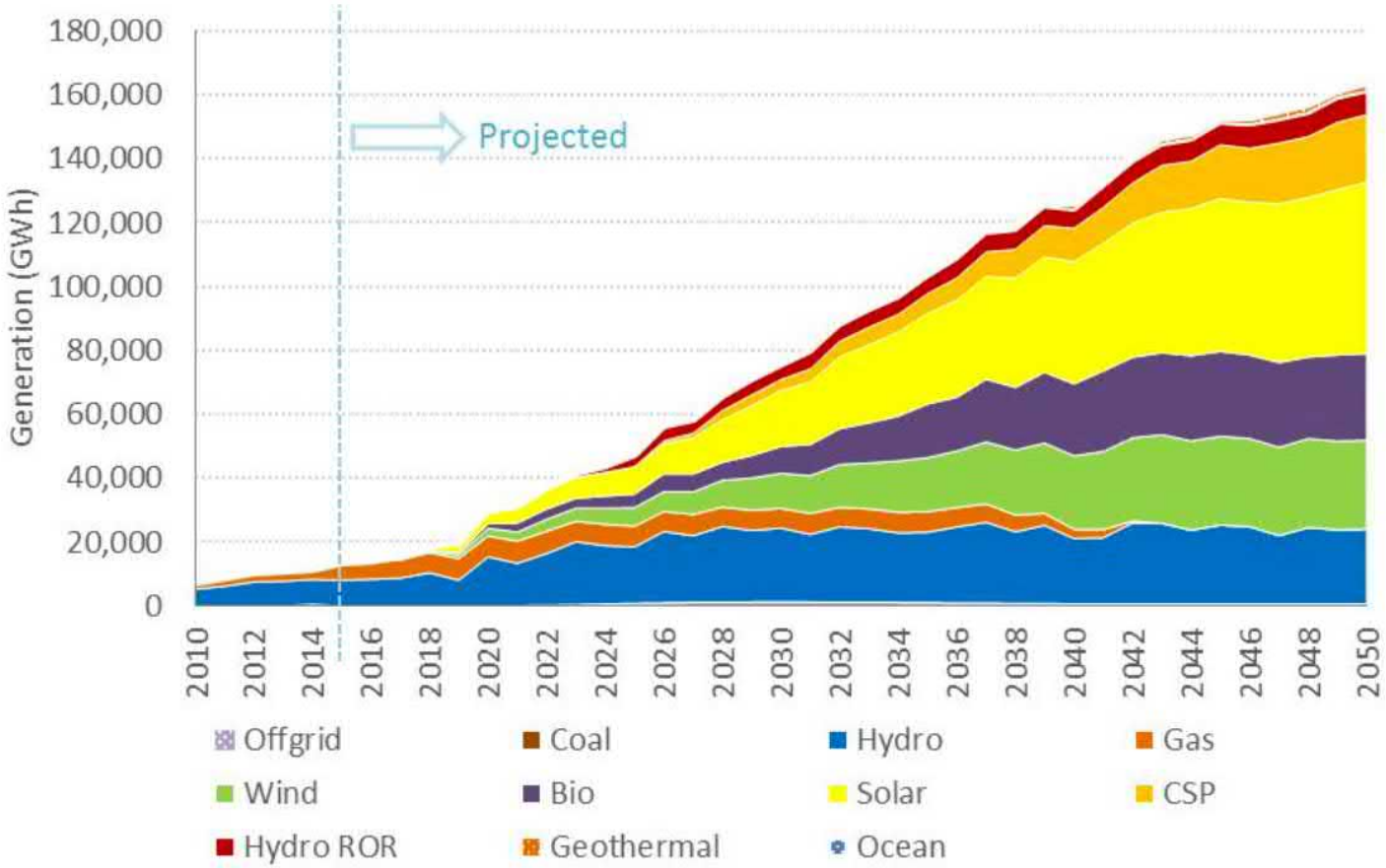
Figure 35 Myanmar Generation Mix (BAU, GWh)



Source: IES and MKE 2017

A mix of solar, wind, biomass and hydropower can supply 100% RE for Myanmar

Figure 48 **Myanmar Generation Mix (SES, GWh)**

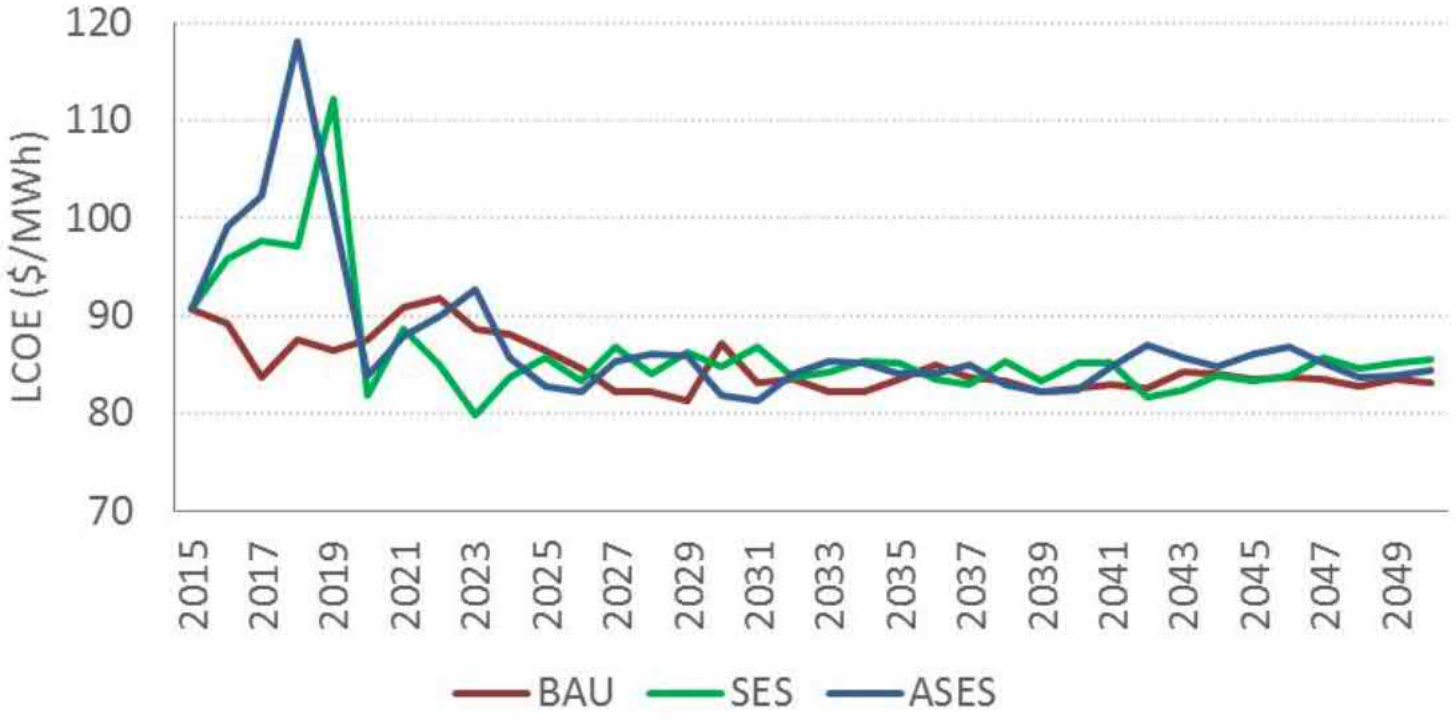


The substantial capacity of storage hydropower will make balancing the system in Myanmar far easier than in Germany!

Source: IES and MKE 2017

The cost of electricity will remain at a similar level

Figure 88 Myanmar LCOE for Generation



Source: IES and MKE 2017

Conclusions

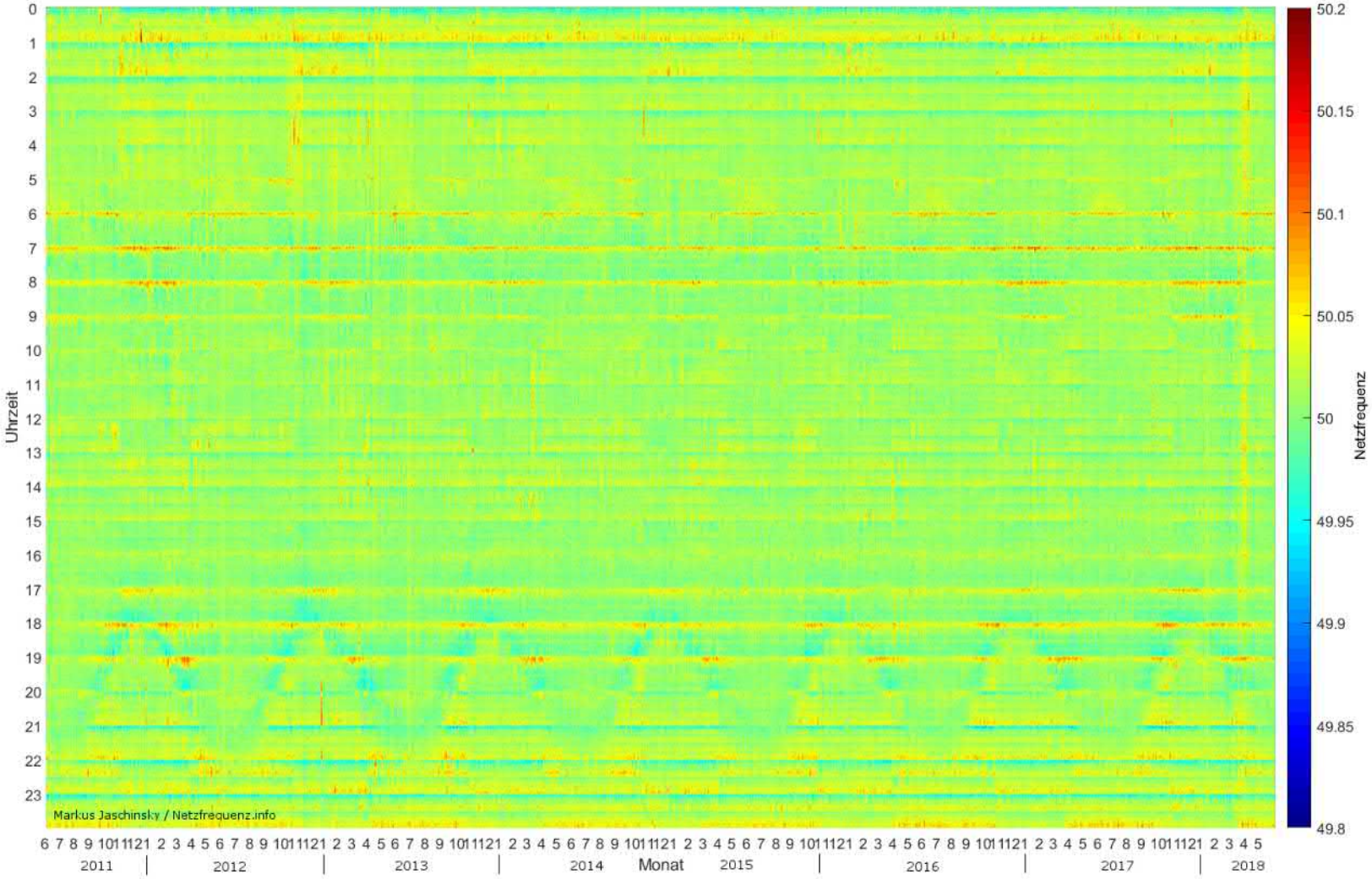
- Myanmar can shift to 100% RE without higher costs
- Myanmar will benefit by higher jobs and less pollution
- A 100% RE strategy can avoid substantial future payments for CO_2 emission charges
- 100% RE power supply may be an important option for Myanmar

- At the moment we lack RE data and a qualified labour force for the implementation of such energy system
- MEEE can help to pave the way for a sustainable energy future for Myanmar

Thank you very much for your attention

Grid stability will not be negatively impacted!

Raster diagram of the grid frequency in Germany 2011 to 2018



In Germany frequency deviations are mostly driven by the hourly electricity trade.
The increased share of renewables has not had any significant impact!

Source:https://www.netzfrequenz.info/auswertungen/langzeitverlauf-der-netzfrequenz-06-2011-05-2018.html