WASTEWATER TREATMENT AND REUSE ENERGY NEXUS IN SAUDI ARABIA

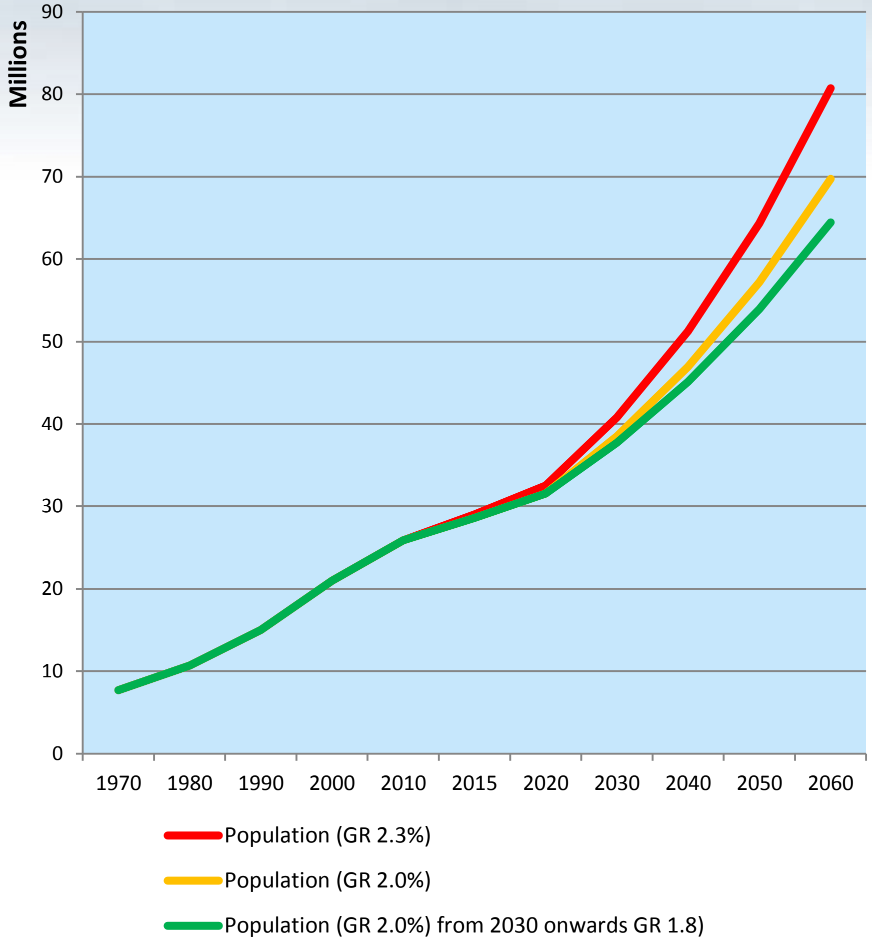
Professor Walid A. Abderrahman (PhD)
Chairman, Miahona
Riyadh, KSA
Walid.a@miahona.com

Miahona
مياهنا

Presentation at
Water Arabia
6nd February, 2013
Al Khober, KSA

CONTENTS

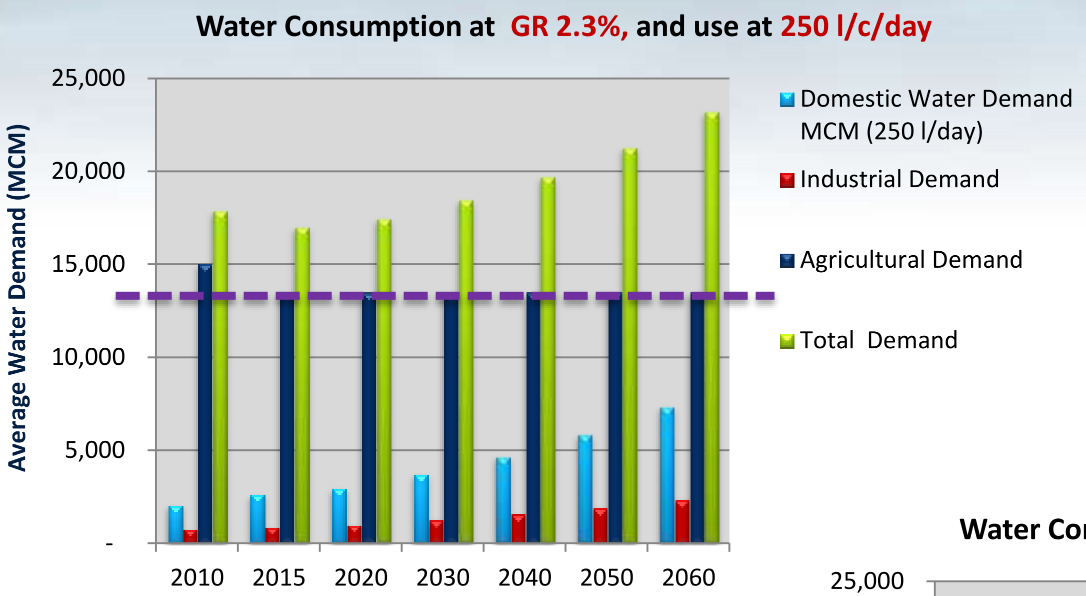
GROWTH IN POPULATION

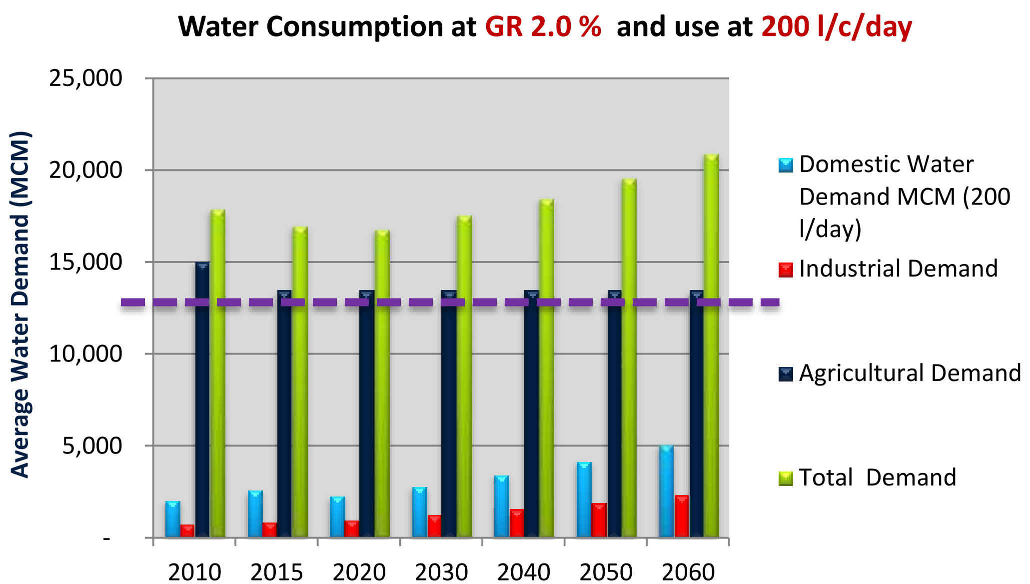


Population Growth in the Kingdom

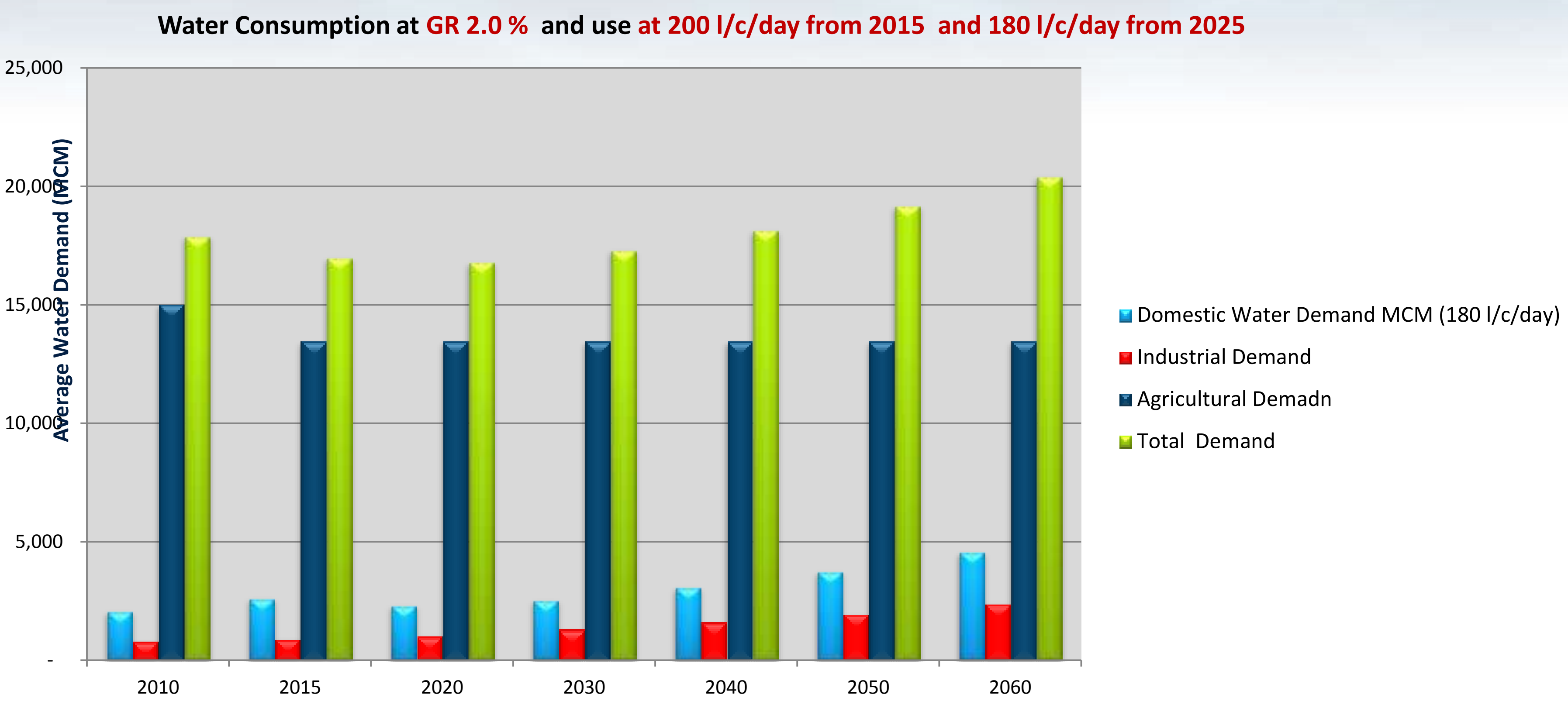
GROWTH OF WATER DEMANDS FOR DOMESTC AND INDUSTRIAL PURPOSES IN KSA

PROJECTED WATER DEMANDS FOR DOMESTIC, INDUSTRIAL & AGRICULTURAL PURPOSES



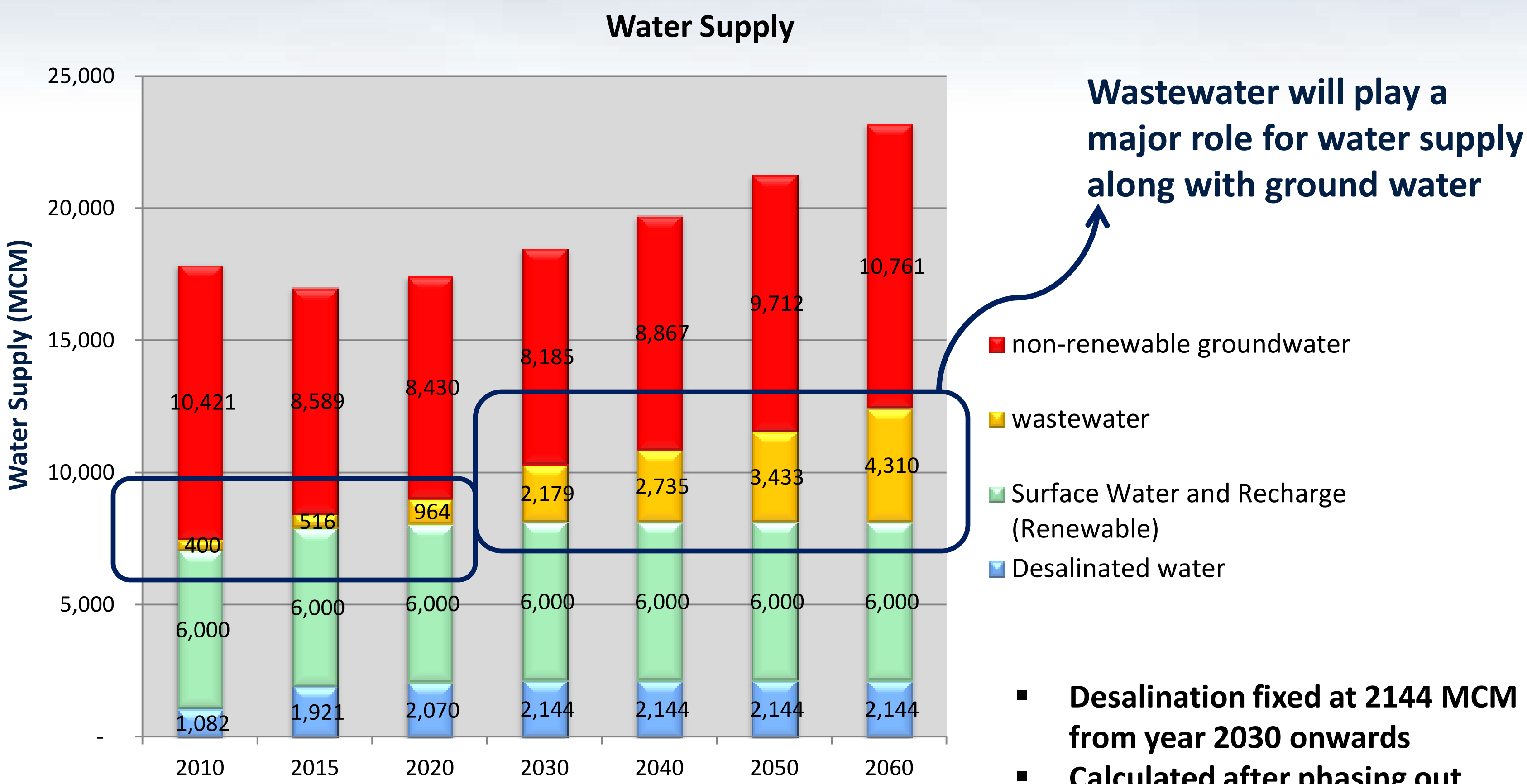


PROJECTED WATER DEMANDS FOR DOMESTIC, INDUSTRIAL & AGRICULTURAL PURPOSES



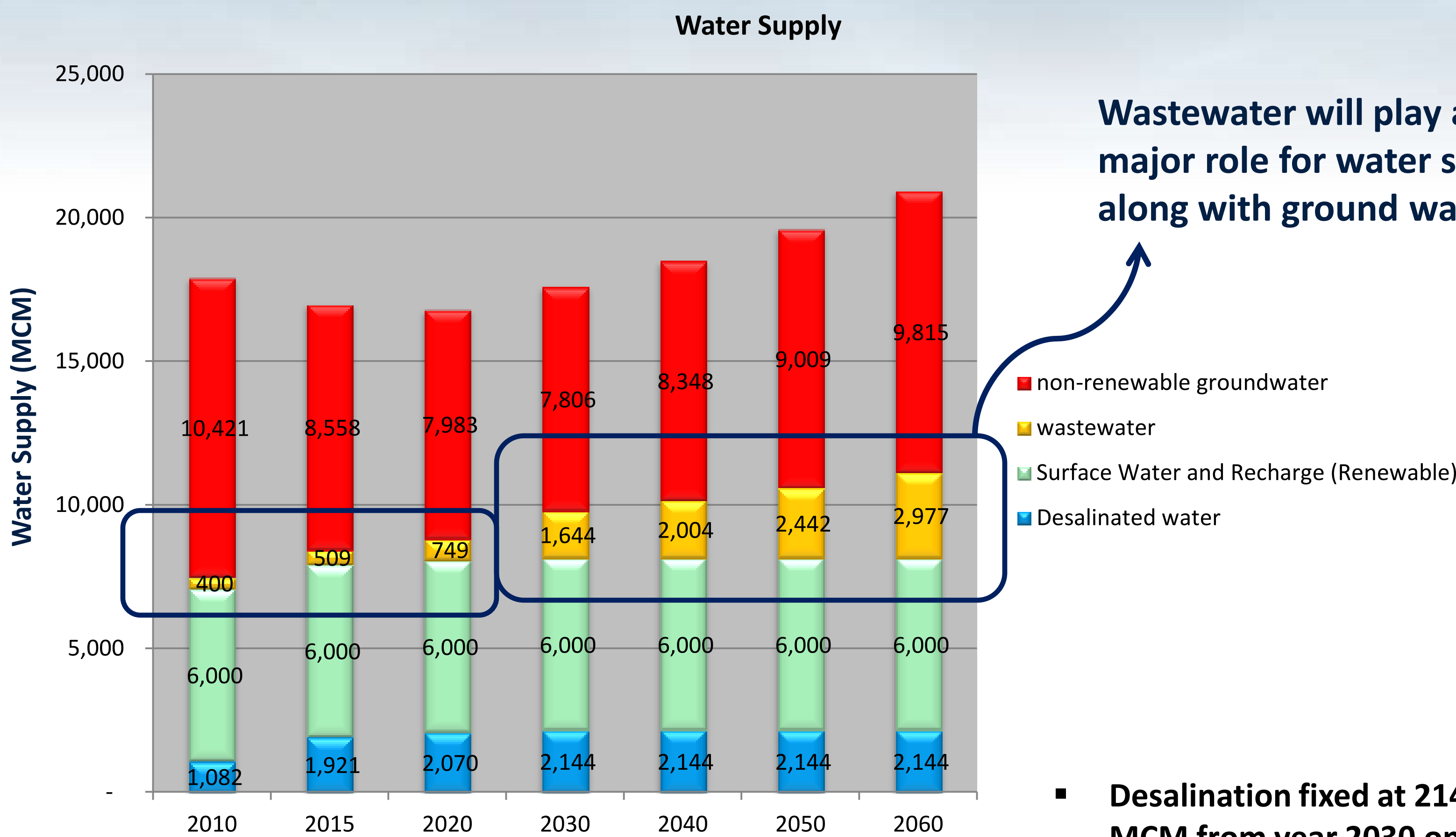
WATER SUPPLY SCENARIOS

WATER SUPPLY FOR ALL DEMAND TYPES BASED ON POPULATION G.R. OF 2.3% AT 250 L/C/DAY



- **Desalination fixed at 2144 MCM from year 2030 onwards**
- **Calculated after phasing out wheat by 2015**

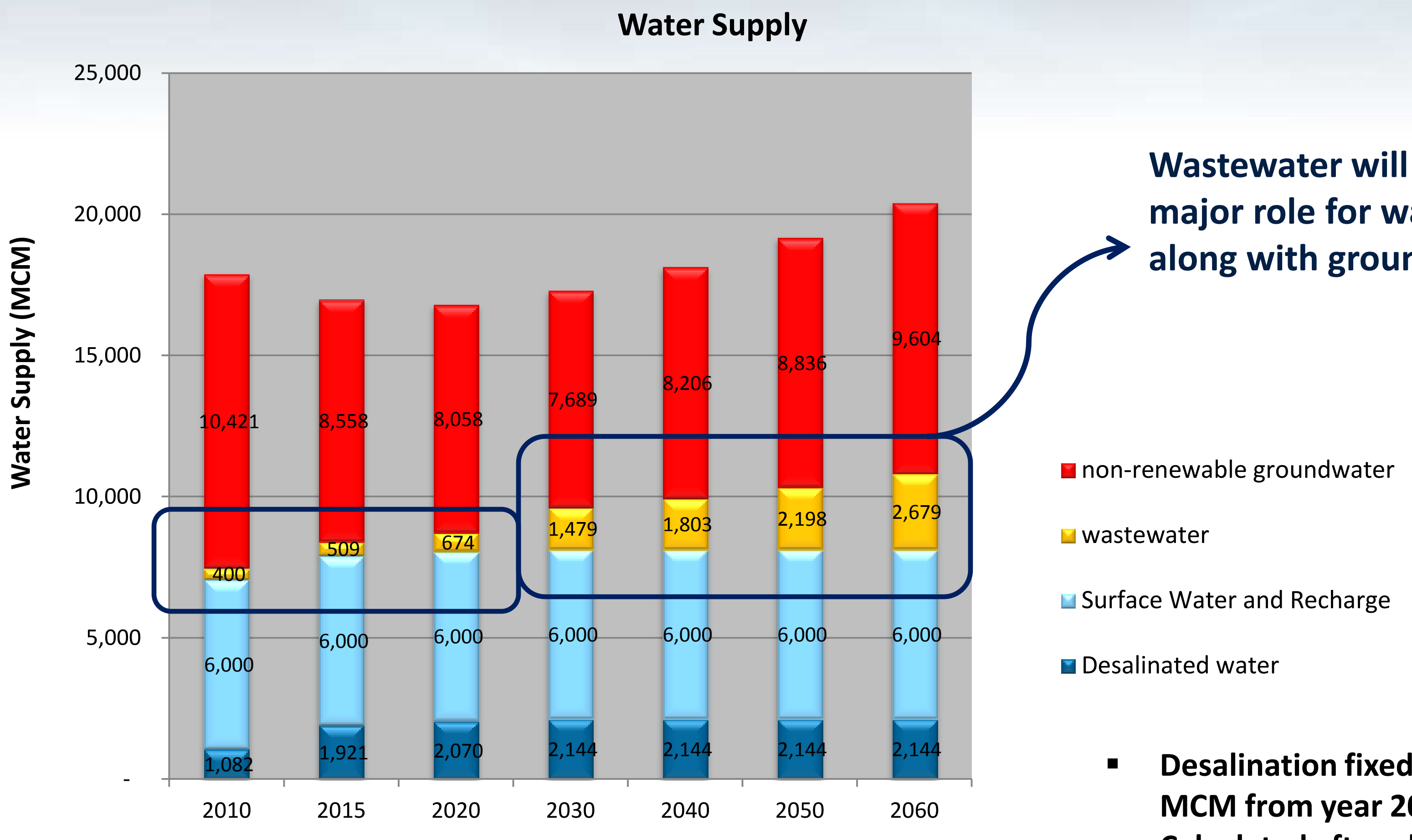
WATER SUPPLY FOR ALL DEMAND TYPES BASED ON POPULATION G.R. OF 2.0% AT 200 L/C/DAY



Wastewater will play a major role for water supply along with ground water

- **Desalination fixed at 2144 MCM from year 2030 onwards**
- **Calculated after phasing out wheat by 2015**

WATER SUPPLY FOR ALL DEMAND TYPES BASED ON POPULATION G.R. OF 2.0% AT 200 L/C/DAY TILL YEAR 2030 & 180 L/C/DAY AFTER YEAR 2030



Wastewater will play a major role for water supply along with ground water

- **Desalination fixed at 2144 MCM from year 2030 onwards**
- **Calculated after phasing out wheat by 2015**

WASTEWATER REUSE IN SAUDI ARABIA

- **Low-cost water supplies from surface and/or groundwater resources have become more difficult alternative resource in Saudi Arabia as explained previously .**
- **Therefore, the water supply planning is shifting from dependence on traditional fresh water resources towards building an environmentally sustainable diversified water supplies.**
- **Low-cost conventional water sources are balanced with more reliable and sustainable water supply alternatives such as water reuse, rain harvesting, and desalination.**
- **Further dependence on highly energy-intensive technologies and practices for water supplies and wastewater treatment is no longer sustainable in a long term**

WASTEWATER REUSE IN SAUDI ARABIA

- Water reuse, in Saudi Arabia, has become an integral part of integrated water resource management to satisfy the rapid growth in water demands. Moreover, water supply and treatment need to be linked more and more to energy demand and energy recovery.

- Water reuse is one of the most cost and energy efficient alternative water source compared to desalination and long distance water transportation.

- Energy-efficient advanced water recycling plants are producing recycled water of drinking water quality with a relatively low energy footprint . The generation of recycled water only requires a fraction of the energy needed for the desalination of seawater.
- Reuse of water can contribute to the saving of valuable freshwater resources. At the same time, water reuse contributes in saving electric power, in particular, when freshwater has to be transported over long distances or further water treatment is required, for example production of potable water from desalination of brackish or seawater.

WASTEWATER REUSE IN SAUDI ARABIA (CONT.)

Water reuse applications of treated municipal wastewater :

- **Agricultural irrigation**
- **Non-potable uses (toilet flushing, landscape irrigation like in parks, golf courses, Greenbelts, residential, freeway medians, school yards, fire protection, air conditioning)**
- **Industrial recycling and reuse (cooling water, boiler feed, process water)**
- **Recreational/environmental uses (lakes and ponds, stream flow augmentation, fisheries)**
- **Groundwater recharge (groundwater replenishment, salt water intrusion control, subsidence control)**
- **Potable reuse (blending in water supply reservoirs, blending in groundwater, etc.,)**

WASTEWATER REUSE IN SAUDI ARABIA (CONT.)

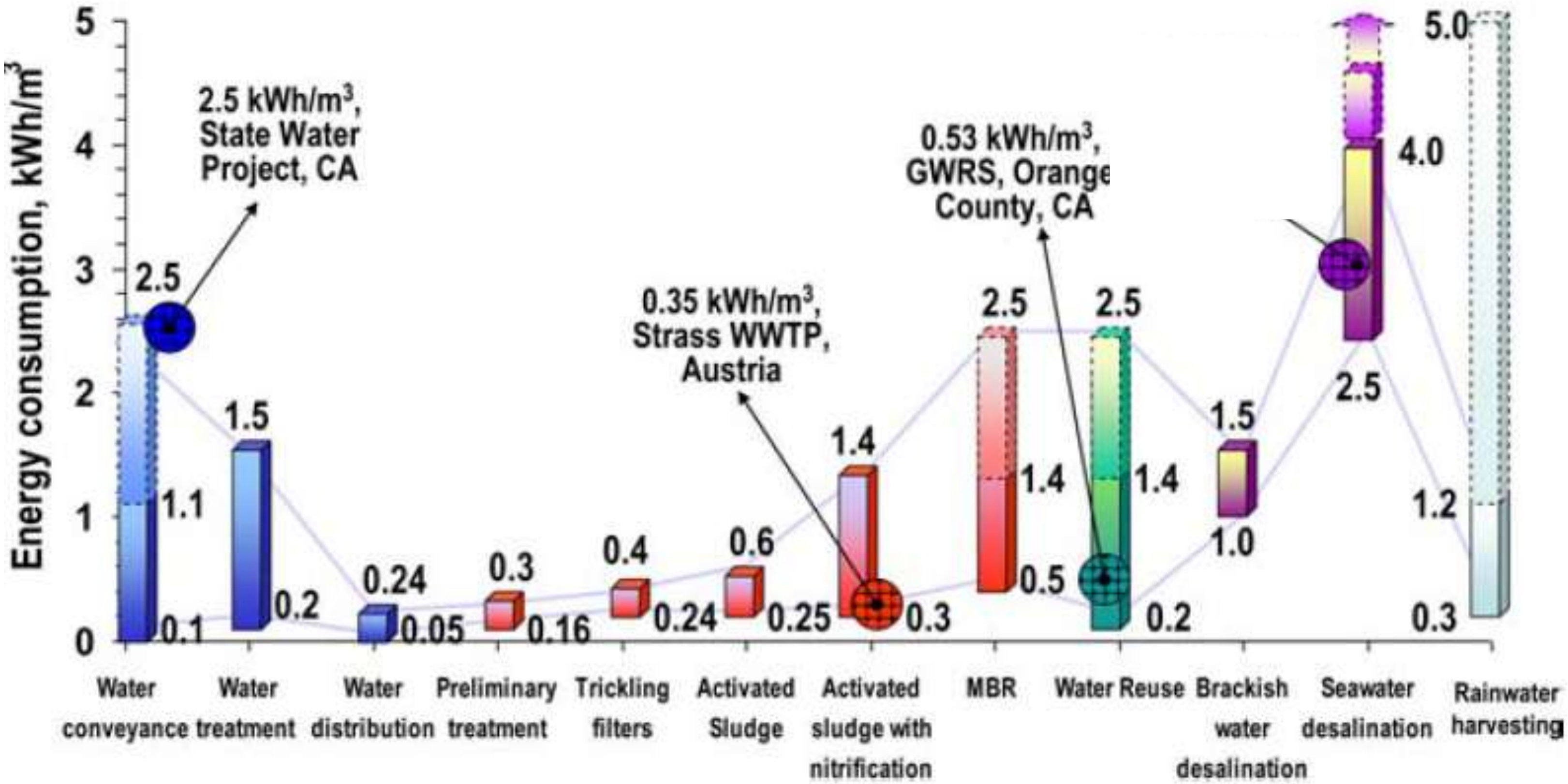
The new trend is going for a regional integrated Water reuse facility which can deliver the following:

- **Treat concentrated wastewater** and solids to a level that satisfy safe disposal into the environment and safe regional reuse,
- **Produce excess energy** in a form of biogas, commercial hydrogen, and electricity,
- **Recover nutrients** in the form of commercial grade form,
- **Sequester carbon** and can provide carbon dioxide for a possible algal biomass production that can be used to produce more energy or commercially processed for biofuel,
- **Produce** nutrient rich organic solids for farms or for production of syngas and charcoal by pyrolysis.
-

ENERGY USE IN WWTP

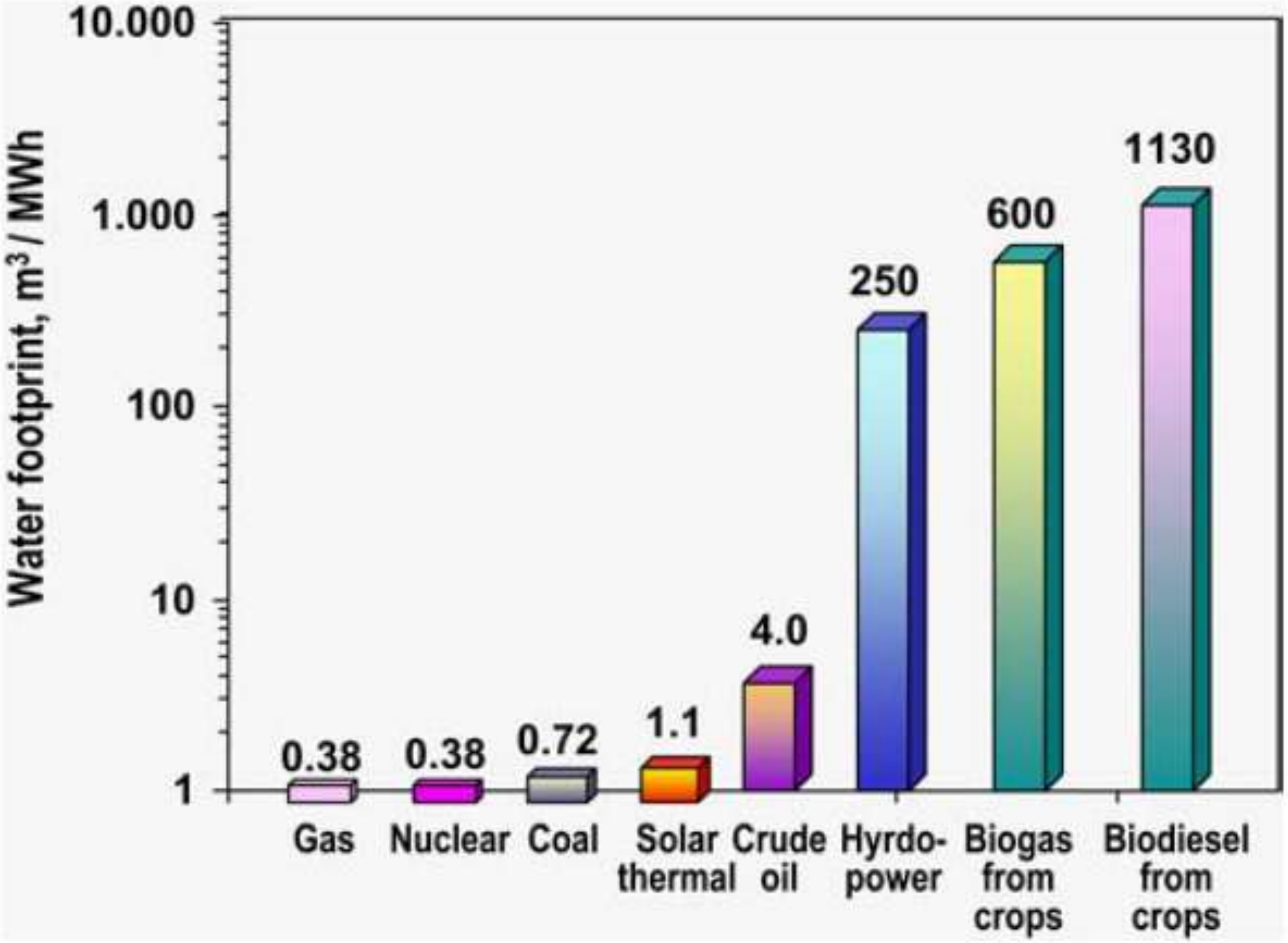
Energy use in wastewater treatment are shifting from full dependence on external power supply sources to self-sufficiency by tapping into the energy naturally embedded into wastewater and green power sources, as well as, by more efficient utilization of available energy resources.

ENERGY FOOTPRINT OF MAJOR ELEMTS AND PROCESSES IN WATER CYCLE MANAGEMENT



Typical energy footprint of the major elements and processes in water cycle management

WATER FOOTPRINT FOR ENERGY PRODUCTION



NEW APPROACHES FOR WWTP WITH SURPLUS ENERGY

Elements for design and operation of WWTP which produces more energy than uses :

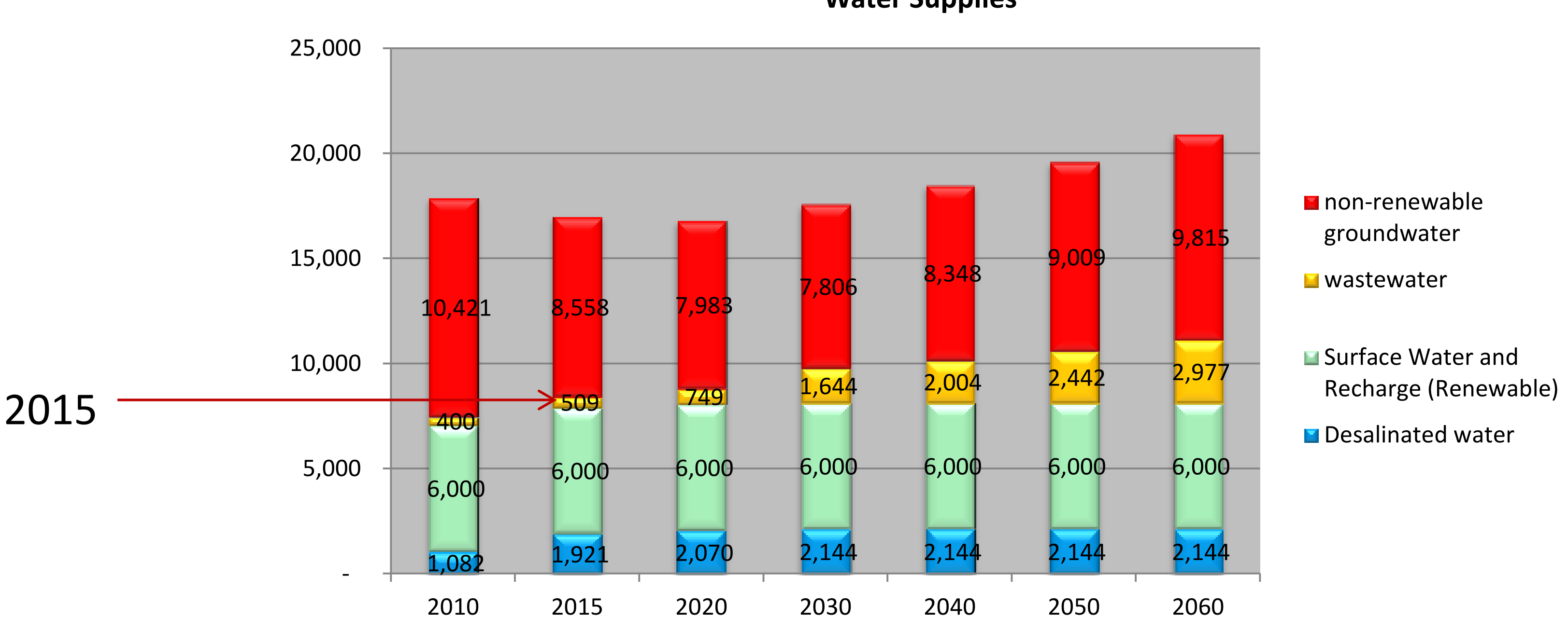
- Energy savings from implementation of technologies and best practices for low energy consumption (up to 20% energy recovery
- Energy recovery from sludge (up to 60–80% energy recovery)
- Energy recovery from sewage flows – thermal, hydraulic, potential (up to 10% energy recovery)
- Production of renewable energy from external sources such as solar, wind or geothermal energy (up to 10% energy recovery)

QUANTITATIVE IMPACTS OF WASTEWATER REUSE ON WATER AND ENERGY SAVINGS IN KSA

- **Wastewater reuse of 509 million m3 in 2015 will result in:**

1)Reduction in production of 254.5 million m3/yr of Sea water desalination, and about 254.5 million m3/yr of fossil groundwater.

2) Saving about 3.5 million MWh to produce and transport 509 million m3 from sea water desalination and groundwater.



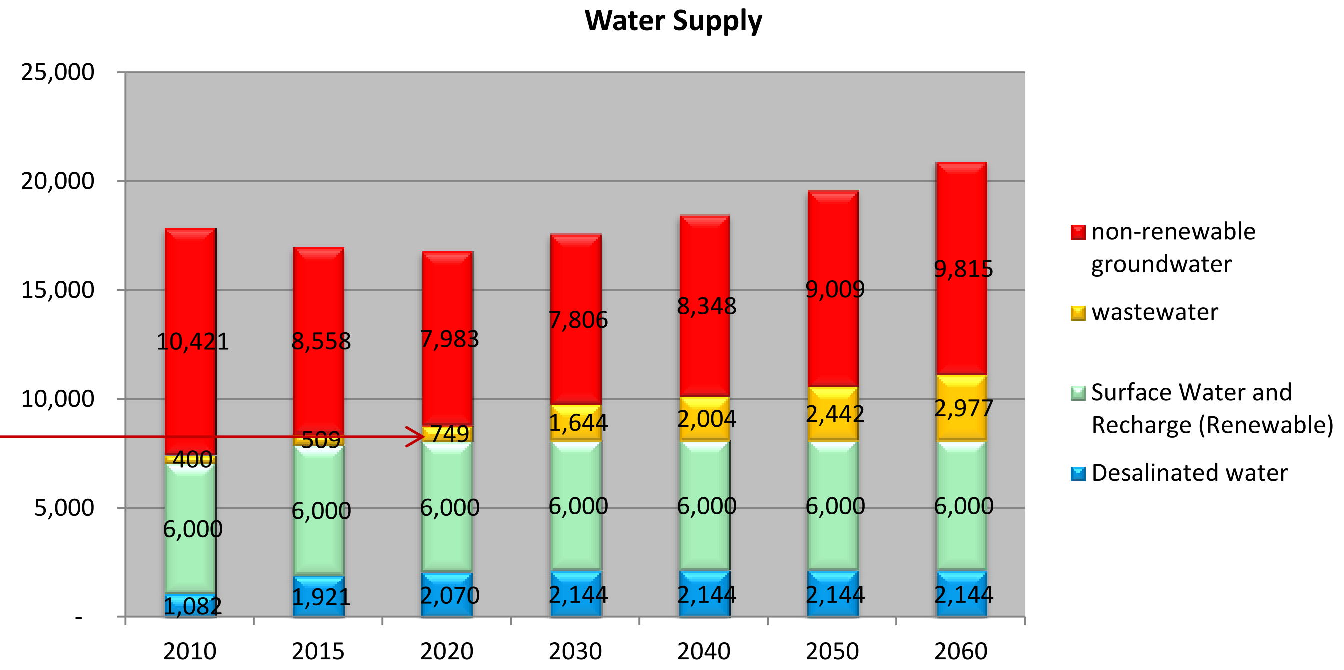
QUANTITATIVE IMPACTS (Continue)

- **Wastewater reuse of 749 million m3 in 2020 will result in:**

1)Reduction in production of 374.5million m3/yr of Sea water desalination, and about 347.5 million m3/yr of fossil groundwater.

2) Saving about 5.19 million MWh to produce and transport 749 million m3 from sea water desalination and groundwate.

2020

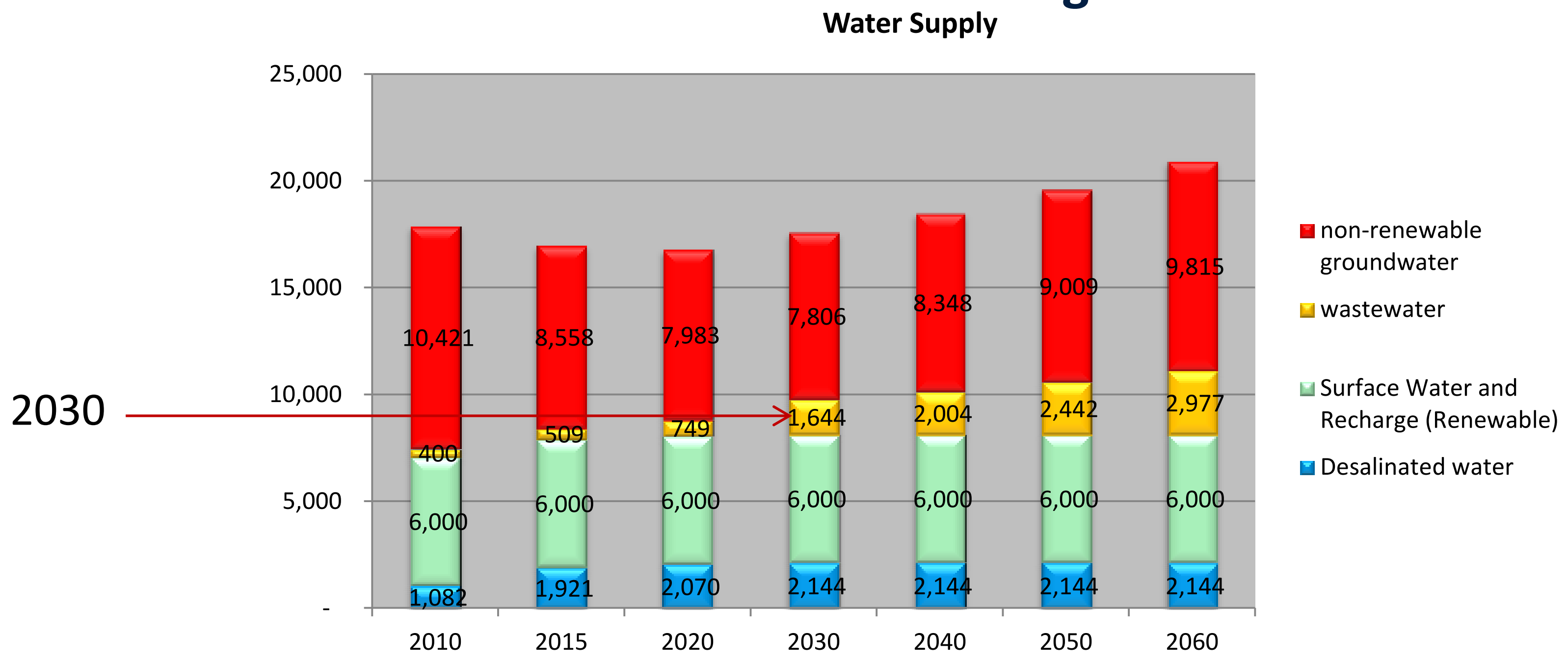


Quantitative Impacts (CONT.)

- **Wastewater reuse of 1644 million m3 in 2030 will result in:**

1)Reduction in production of 822 million m3/yr of Sea water desalination, and about 822 million m3/yr of fossil groundwater.

2) Saving about 10 million MWh to produce and transport 1644 million m3 from sea water desalination and groundwater.

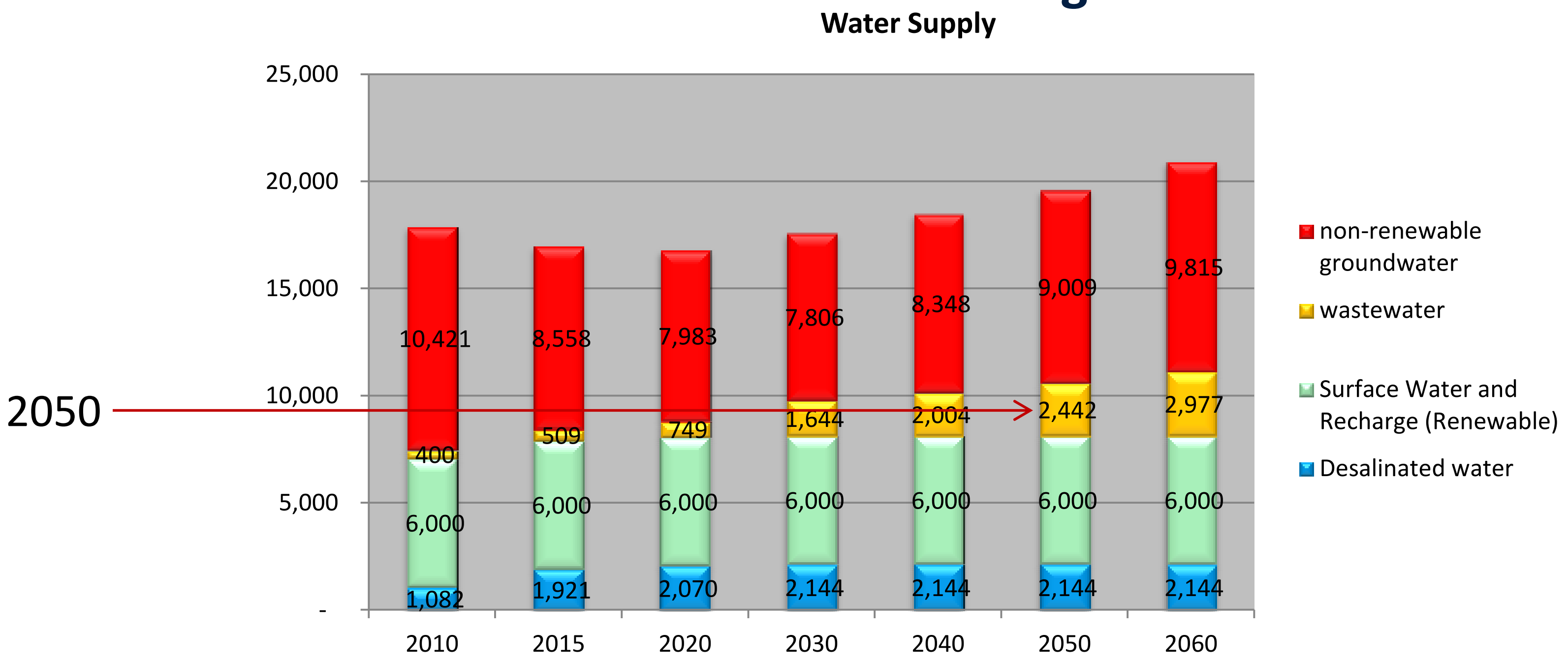


WASTEWATER REUSE IMPACTS (CONT.)

- **Wastewater reuse of 2442 million m3 in 2050 will result in:**

1)Reduction in production of 1221 million m3/yr of Sea water desalination, and about 1221 million m3/yr of fossil groundwater.

2) Saving about 14.8 million MWh to produce and transport 1221 million m3 from sea water desalination and groundwater.



NEW TECHNOLOGIES For Energy Production IN WWTP

- New technologies such as the microbial fuel cell and affiliated technologies use bacteria to directly produce an electrical current which can be used to power the wastewater treatment plant, and additionally to provide electricity for potable water treatment . On the other side, microbial electrolysis cells allow biogas recovery (hydrogen or methane) and microbial desalination cells have the potential to change desalination in the future

CONCLUSIONS

- Solving water-energy nexus to preserve our environment is no doubt the challenge of this century. Rapid growth in human population and improving living standards have resulted in excessive use of water and energy resources, losses of biodiversity, and even climate change. Consequently, it is important to reshape our approaches of development, especially in terms of holistic management of water and energy.

- Water and energy can not be managed separately, but they should be dealt jointly, and the water cycle should be managed in sustainable way that minimizes consumption and maximizes recovery.

- Wastewater has become a major water resource for different water reuse purposes, and also as a source of nutrients and organic constituents, which are potential sources of energy

CONCLUSIONS (CONT.)

- I believe strongly in the following statement :

The sun is the source of all energy on Earth and water is the basis of all life on our planet. It is our commitment, as water professionals, researchers and decision makers, to safeguard the main drivers of the life on our planet and therefore, the long term sustainability of our civilization: water and energy.

THANK YOU

ENERGY CONSUMPTION BY DESALINATION AND GROUNDWATER PUNPING

- A single stage desalination plant, well designed with high efficiency level requires about 4 kWh/m^3 and 0.5-2.5 kWh/m^3 to produce one cubic meter of good quality water from sea water and brackish groundwater respectively.
- An average of about 5.5 kWh/m3 is used for desalinated water transportation. About 85,000 wells were drilled to satisfy the increasing irrigation water demands. The energy requirements to pump one cubic meter from wells range between 0.4–0.8 kWh.